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JOURNAL OF THE SOCIETY OF ARTS.

No. 1,461.] FRIDAY, NOVEMBER 19, 1880. [Vol. XXIX.

ONE HUNDRED AND TWENTY-SEVENTH SESSION, 1880-81.

Arrangements for the Session.

The First Meeting of the One Hundred and Twenty-Seventh Session of the Society was held on Wednesday, the 17th inst., when the Opening Address was delivered by F. J. Bramwell, F.R.S., Chairman of the Council. Previous to Christmas there will be Four Ordinary Meetings, when papers will be read by Mr. J. Comyns Carr, Mr. A. G. Lock, Dr. Alfred Carpenter, and Mr. E. Price Edwards.

Ordinary Meetings.

Wednesday Evenings, at Eight o'clock. For Meetings previous to Christmas :—

November 17.—Opening Meeting of the Session. Address by F. J. Bramwell, F.R.S., Chairman of the Council.

November 24.—"The Influence of Barry upon English Art." By J. Comyns Carr.

December 1.—"Causes of Success and Failure in Modern Gold Mining." By A. G. Lock.

December 8.—"London Fogs." By Dr. Alfred Carpenter.

December 15.—"The Use of Sound for Signals." By E. Price Edwards, Secretary to the Deputy-Master of the Trinity-house. On this evening Dr. Tyndall, F.R.S., will preside.

For Meetings after Christmas :—

"The Photophone." By W. H. Preece, Pres. Soc. Tel. Engineers.

"Buying and Selling; its Nature and its Tools." By Prof. Bonamy Price. On this evening Lord Alfred S. Churchill will preside.

"The Participation of Labour in the Profits of Enterprise." By Sedley Taylor, M.A., late Fellow of Trinity College, Cambridge.

"The Gold Fields of India." By Hyde Clarke.

"Flashing Signals for Lighthouses." By Sir William Thomson, F.R.S.

"The Present Condition of the Art of Wood-carving in England." By J. Hungerford Pollen.

"Five Years' Experience of the Working of the Trade Marks' Registration Acts." By Edmund Johnson.

"Trade Prospects." By Stephen Bourne.

"The Manufacture of Aërated Waters." By T. P. Bruce Warren.

"The Compound Air Engine." By Col. F. Beaumont, R.E.

"Improvements in the Treatment of Esparto for the Manufacture of Paper." By William Arnot, F.C.S.

"Deep Sea Investigation, and the Apparatus used in it." By J. G. Buchanan, F.R.S.E., F.C.S.

"The Discrimination and Artistic Use of Precious Stones." By Prof. A. H. Church, F.C.S.

"The Forests of India." By Sir Richard Temple, Bart., K.C.S.I.

"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

"Indian Agriculture." By W. R. Robertson.

"Trade Relations between Great Britain and her Dependencies." By Wm. Westgarth.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

February 1, 22 ; March 15 ; April, 5 ; May 10, 31.

Applied Chemistry and Physics Section.

The meetings of this Section will take place on the following Thursday Evenings, at Eight o'clock :—

January 27 ; February 24 ; March 24 ; April 7, 28 ; May 26.

Indian Section.

The meetings of this Section will take place on the following Friday Evenings, at Eight o'clock :—

January 21 ; February 11 ; March 4, 25 ; April 29 ; May 13.

Cantor Lectures.

The First Course will be on "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain," by Prof. A. H. Church, F.C.S. Five Lectures.

The Second Course will be on "Watchmaking," by Edward Rigg, M.A. Three Lectures.

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Four Lectures.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

SYLLABUS OF THE FIRST COURSE.

Lecture I.—November 22.

Bricks, tiles, terra-cotta, basaltes, and unglazed earthenware in general.

Lecture II.—November 29.

Vitreous, plumbiferous, boracic, and felspathic glazes and enamels. Iridescent and metallic lustres, and colouring substances.

Lecture III.—December 6.

Stoneware and other wares glazed with salt.

Lecture IV.—December 13.

Soft paste porcelains, European and Oriental.

Lecture V.—December 20.

Hard paste porcelains, Chinese, Japanese, and European.

Juvenile Lectures.

The usual short Course of Lectures adapted for a Juvenile audience will be given by G. J. Romanes, F.R.S., on "Animal Intelligence." The dates for the lectures will be 29th December and 5th January. The lectures will commence at 7 o'clock. Special tickets will be issued for these lectures.

Proceedings of the Society.

CHARTER.—THE SOCIETY OF ARTS was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom; and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British commerce; and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures and Commerce of this country."

THE SESSION.—The Session commences in November and ends in June. The number of Meetings held during the Session amounts to between 70 and 80.

ORDINARY MEETINGS.—At the Wednesday Evening Meetings during the Session, papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country are read and discussed.

INDIAN SECTION.—This Section was established in 1869, for the discussion of subjects connected with our Indian Empire. Six or more Meetings are held during the Session.

FOREIGN AND COLONIAL SECTION.—This Section was formed in 1874, under the title of the African Section, for the discussion of subjects connected with the Continent of Africa. It was enlarged, in 1879, so as to include the consideration of subjects connected with our Foreign and Colonial Possessions generally. Six or more Meetings are held during the Session.

APPLIED CHEMISTRY AND PHYSICS SECTION.—This Section was formed in 1874, for the discussion of subjects connected with Practical Chemistry and its application to the Arts and Manufactures. It was enlarged in 1879 so as to include the consideration of subjects connected also with the Applications of Physical Science to the Arts. Six or more Meetings are held during the Session.

CANTOR LECTURES.—These Lectures originated in 1863, with a bequest by the late Dr. Cantor. There are Three or more Courses every Session, and each course consists generally of from Three to Six Lectures.

ADDITIONAL LECTURES.—Special courses of Lectures are occasionally given.

JUVENILE LECTURES.—A short Course of Lectures, suited for a Juvenile audience, is delivered to the Children of Members during the Christmas Holidays.

ADMISSION TO MEETINGS.—Members have the right of attending the above meetings and Lectures. They require no tickets, but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor and other Lectures. Books of tickets for the purpose are supplied to the Members, but admission can be obtained on the personal introduction of a Member. For the Juvenile Lectures special tickets are issued.

JOURNAL OF THE SOCIETY OF ARTS.—The *Journal*, which is sent free to Members, is published weekly, and contains full Reports of all the Society's Proceedings, as well as a variety of information connected with Arts, Manufactures, and Commerce.

EXAMINATIONS.—The Society's Examinations now comprise the following divisions:—1. Political Economy. 2. Domestic Economy—(*a*) Cooking; (*b*) Clothing; (*c*) Health; (*d*) Housekeeping and Thrift. 3. Music—(*a*) Theory; (*b*) Practice. 4. Elementary. The Programme for 1881 can be had on application to the Secretary.

LIBRARY AND READING-ROOM.—The Library and Reading-room are open to Members, who are also entitled to borrow books.

CONVERSAZIONI are held, to which the Members are invited, each Member receiving a card for himself and a Lady.

Membership.

The Society numbers at present between three and four thousand Members. The Annual Subscription is Two Guineas, or a Life Subscription of Twenty Guineas may be paid.

Every Member whose subscription is not in arrear is entitled:—

To be present at the Evening Meetings of the Society, and to introduce two visitors at such meetings, subject to such special arrangements as the Council may deem necessary to be made from time to time.

To be present and vote at all General Meetings of the Society.

To be present at the Cantor and other Lectures, and to introduce one visitor.

To have personal free admissions to all exhibitions held by the Society at its house in the Adelphi.

To be present at all the Society's *Conversazioni*.

To receive a copy of the Weekly *Journal* published by the Society.

To the use of the Library and Reading-room.

Candidates for Membership are proposed by three Members, one of whom, at least, must sign on personal knowledge; or are nominated by the Council. The Annual Subscription is Two Guineas, payable in advance, and dates from the quarter-day immediately preceding election; or a sum of Twenty Guineas in lieu of all further contributions, may be paid.

All subscriptions should be paid to the Secretary, H. T. Wood, and all Cheques or Post-office Orders should be crossed "Coutts and Company," and forwarded to him at the Society's House, John-street, Adelphi, London, W.C.

Calendar for the Session.

The following is the Calendar for the Session 1880-81. It is issued subject to any necessary alterations:—

NOVEMBER, 1880.

1	M	
2	Tu	
3	W	
4	Th	
5	F	
6	S	
7	S	
8	M	
9	Tu	
10	W	
11	Th	
12	F	
13	S	
14	S	
15	M	
16	Tu	
17	W	Ordinary Meeting. (Opening Meeting of the Session.)
18	Th	
19	F	
20	S	
21	S	
22	M	Cantor Lecture I. 1
23	Tu	
24	W	Ordinary Meeting
25	Th	
26	F	
27	S	
28	S	
29	M	Cantor Lecture I. 2
30	Tu	

DECEMBER, 1880.

1	W	Ordinary Meeting
2	Th	
3	F	
4	S	
5	S	
6	M	Cantor Lecture I. 3
7	Tu	
8	W	Ordinary Meeting
9	Th	
10	F	
11	S	
12	S	
13	M	Cantor Lecture I. 4
14	Tu	
15	W	Ordinary Meeting
16	Th	
17	F	
18	S	
19	S	
20	M	Cantor Lecture I. 5
21	Tu	
22	W	
23	Th	
24	F	
25	S	Christmas Day
26	S	
27	M	Bank Holiday
28	Tu	
29	W	Juvenile Lecture 1
30	Th	
31	F	

JANUARY, 1881.

1	S	
2	S	
3	M	
4	Tu	
5	W	Juvenile Lecture 2
6	Th	
7	F	
8	S	
9	S	
10	M	
11	Tu	
12	W	Ordinary Meeting
13	Th	
14	F	
15	S	
16	S	
17	M	
18	Tu	
19	W	Ordinary Meeting
20	Th	
21	F	Indian Meeting
22	S	
23	S	
24	M	
25	Tu	
26	W	Ordinary Meeting
27	Th	Chem. & Phys. Meet.
28	F	
29	S	
30	S	
31	M	

FEBRUARY, 1881.

1	Tu	For. & Col. Meet.
2	W	Ordinary Meeting
3	Th	
4	F	
5	S	
6	S	
7	M	Cantor Lecture II. 1
8	Tu	
9	W	Ordinary Meeting
10	Th	
11	F	Indian Meeting
12	S	
13	S	
14	M	Cantor Lecture II. 2
15	Tu	
16	W	Ordinary Meeting
17	Th	
18	F	
19	S	
20	S	
21	M	Cantor Lecture II. 3
22	Tu	For. & Col. Meet.
23	W	Ordinary Meeting
24	Th	Chem. & Phys. Meet.
25	F	
26	S	
27	S	
28	M	

MARCH, 1881.

1	Tu	
2	W	Ordinary Meeting
3	Th	
4	F	Indian Meeting
5	S	
6	S	
7	M	Cantor Lecture III. 1
8	Tu	
9	W	Ordinary Meeting
10	Th	
11	F	
12	S	
13	S	
14	M	Cantor Lecture III. 2
15	Tu	For. & Col. Meet.
16	W	Ordinary Meeting
17	Th	
18	F	
19	S	
20	S	
21	M	Cantor Lecture III. 3
22	Tu	
23	W	Ordinary Meeting
24	Th	Chem. & Phys. Meet.
25	F	Indian Meeting
26	S	
27	S	
28	M	Cantor Lecture III. 4
29	Tu	
30	W	Ordinary Meeting
31	Th	

APRIL, 1881.

1	F	
2	S	
3	S	
4	M	Cantor Lecture IV. 1
5	Tu	For. & Col. Meet.
6	W	Ordinary Meeting
7	Th	Chem. & Phys. Meet.
8	F	
9	S	
10	S	
11	M	Cantor Lecture IV. 2
12	Tu	
13	W	
14	Th	
15	F	Good Friday.
16	S	
17	S	Easter Sunday
18	M	Bank Holiday
19	Tu	
20	W	
21	Th	
22	F	
23	S	
24	S	
25	M	
26	Tu	
27	W	Ordinary Meeting
28	Th	Chem. & Phys. Meet.
29	F	Indian Meeting
30	S	

MAY, 1881.

1	S	
2	M	Cantor Lecture IV. 3
3	Tu	
4	W	Ordinary Meeting
5	Th	
6	F	
7	S	
8	S	
9	M	Cantor Lecture IV. 4
10	Tu	For. & Col. Meet.
11	W	Ordinary Meeting
12	Th	
13	F	Indian Meeting
14	S	
15	S	
16	M	Cantor Lecture V. 1
17	Tu	
18	W	Ordinary Meeting
19	Th	
20	F	
21	S	
22	S	
23	M	Cantor Lecture V. 2
24	Tu	
25	W	Ordinary Meeting
26	Th	Chem. & Phys. Meet.
27	F	
28	S	
29	S	
30	M	Cantor Lecture V. 3
31	Tu	For. & Col. Meet.

JUNE, 1881.

1	W	
2	Th	
3	F	
4	S	
5	S	Whit-Sunday
6	M	Bank Holiday
7	Tu	
8	W	
9	Th	
10	F	
11	S	
12	S	
13	M	
14	Tu	
15	W	
16	Th	
17	F	
18	S	
19	S	
20	M	
21	Tu	
22	W	Conversazione at the South Kensington Museum
23	Th	
24	F	
25	S	
26	S	
27	M	
28	Tu	
29	W	Annual General Meeting
30	Th	

The chair will be taken at eight o'clock at each of the above meetings, except the Annual General Meeting.

The Annual General Meeting will be held at four o'clock.

NOTICES.

THE PHOTOPHONE.

The paper on "The Photophone," by Mr. W. H. Preece, Pres. Soc. Tel. Engineers, announced for reading on the 1st December, has been unavoidably postponed until after Christmas. Mr. Alfred Lock's paper on the "Causes of Success and Failure in Modern Gold Mining," will be read in its place on that day.

INDIAN SECTION COMMITTEE.

A meeting of the Committee of the Indian Section, was held on Monday, 15th inst, at 4 p.m., Present:—Mr. Andrew Cassels (in the chair), Dr. Birdwood, C.S.I., Sir George Campbell, K.C.S.I., M.P., Lord Alfred S. Churchill, Sir William Rose Robinson, K.C.S.I., Mr. J. T. Wood, with Mr. H. Trueman Wood, Secretary, and Colonel Hardy, Secretary of the Section. The programme of papers to be read during the present session was discussed and decided upon.

PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

Wednesday, November 17th, 1880; F. J. BRAMWELL, F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Allcock, Arthur Thomas, 5, Spring-gardens, Newark-upon-Trent.
Atkinson, Frederick William, 137, Leadenhall-street, E.C.
Aylmer, Capt. John Evans-Freke, M.P., Aylmersfield, Streatham.
Baillie, J. H., 15, Old Bond-street, W.
Baxter, F., South Eastern-wharf, Park-street, S.E.
Bell, R., 83, Knightrider-street, E.C.
Bennet, Peter Duckworth, Edgbaston, Birmingham.
Biggs, Benjamin, 3, Lawrence Pountney-hill, E.C.
Blackwood, Richard, 96, Cromwell-road, South Kensington, S.W.
Blamires, Thomas Howard, Close-hill, Lockwood, near Huddersfield.
Blyth, James, 31, Park-terrace, Regent's-park, N.W.
Capel, Frank C., The Mount, Wilmington, Kent.
Carpmael, Alfred, 1, Copthall-buildings, E.C.
Clark, William Timbrell, Kilsby, near Rugby.
Collington, James B., Beeston, Nottinghamshire.
Comerma, Capt. Andrés A., 48, Macfarlane-road, Shepherd's-bush, W.
Cottew, William Stokes, The Bank, Tottenham.
Cranwell, William B., 42, Portsdown-road, W.
Crookenden, Isaac Adolphus, Marlborough-house, Blackheath, S.E.
Deane, James Parker, D.C.L., Q.C., 3, Paper-buildings, Temple, E.C., and 16, Westbourne-terrace, W.
Deaville, Rev. Joseph Gibson, Agincourt-villa, Bury, Lancashire.
Dewrance, John, 176, Great Dover-street, S.E.
Eaton, Francis James, Albert-road, Hesketh-park, Southport, Lancashire.
Emptage, Daniel, Dane-hill Sanitary Works, Margate.
Estcourt, R. M., Local Government Board, S.W.
Evans, Lieut.-Colonel John, Highfield, Derby.
Ford, George Benjamin, 196, Westminster-bridge-road, S.E., and 9, Cuthill-road, Denmark-hill, S.E.
Freeman, William George, 44, Kensington-square, W.
Gordon, C. A., M.D., C.B., 70, Cambridge-gardens, W.
Grant, Sir John Peter, K.C.B., G.C.M.G., The Doune of Rothiemurchus, Aviemore, N.B.
Greenall, Lieut.-Colonel James Fenton, Lingholme, Derwentwater, Cumberland.
Guest, Montague J., M.P., 3, Savile-row, W., and Bere Regis, Blandford, Dorset.
Guthrie, Herbert, 32, Brown-street, Manchester.
Hall, Alexander Lyons, F.R.G.S., Lyon's-court, Ladbroke-road, Holland-park, W.
Harper, George Thomas, Southampton.
Harvey, William Charles, 12, Old-square, Lincoln's-inn, W.C., and 8, Warwick-road, Maida-hill West, W.
Haynes, F., Superintendent's Office, Telegraph Department, G.W.R., Taunton.
Heyworth, Lieut.-Colonel Lawrence, Wain Vawr, near Newport, Monmouth.
Hickman, Alfred, Goldthorn-hill, near Wolverhampton.
Homan, Ebenezer, Friern Watch, Finchley, N.
Hulse, Joseph, Dresden, Longton, Staffordshire.
Isaac, Benjamin, 102, Piccadilly, W.
Johnson, Walter Claude, Rivoli, Old Charlton, Kent.
Judson, Frederick Henry, 77, Southwark-street, S.E.
Keyser, Charles Edward, M.A., F.S.A., Merry-hill-house, Bushey, Herts.
Lambe, J. B., 199, Upper Thames-street, E.C., and 427, New-cross-road, S.E.
Lightfoot, Thomas Bell, 2, Granville-park, Blackheath, S.E.
Lingard-Monk, Richard Boughey Monk, 4, Westminster-chambers, S.W., and Fulshaw-hall, Wilmslow, Cheshire.
Lovell, Richard J., 48, Oakley-road, Canonbury, N.
McDonald, James E., 4, Chapel-street, Cripplegate, E.C.
Marriner, William Tyler, Eton-villa, King Edward's-road, South Hackney, E.
Marshall, Alfred, The Villa, Muswell-hill, N.
Martin, John Cowdery, White Lead Works, Ossory-road, Old Kent-road, S.E.
Mineard, George Edward, 57, Warwick-road, South Kensington, S.W.
Moser, Charles E. Brooklyn, 75, Upper Tulse-hill, S.W.
Neal, James, 21, Lime-street, E.C.
Nyland, James, 42, Burlington-road, St. Stephen's-square, Bayswater, W.
Paddon, Samuel Wreford, Brooklyn, Chislehurst.
Pearson, Joseph Hickman, J.P., The Leveretts, Handsworth, near Birmingham.
Pfoundes, Charles, 1, Cleveland-row, St. James's, S.W.
Pickering, Charles William Harrison, J.P., New Brighton, Cheshire.
Pinnock, Henry, J.P., Beechwood, Newport, Isle of Wight.
Pursell, John Roger, Kingston-road, Merton, Surrey.
Puzey, William, 5, Aldermanbury-postern, E.C.
Quincey, Edmund de Quincey, 76, Avenue-road, Regent's-park, N.W.
Ravenscroft, Sidney Horace, Powis-lodge, Haverstock-hill, N.W.
Robinson, John, F.G.S., Kingscote, East Grinstead.
Robson, John, Tynemouth-road, The Green, Tottenham.
Rogers, J. H., Llanelly, Carmarthenshire.

Rothwell, Richard, 45, Holland road, Kensington, W.
Rudd, William Albert, Gloucester-house School Science and Art Classes, Dodington, near Sittingbourne.
Simpson, George Palgrave, 2, Mount-terrace, Richmond, Surrey.
Sonnenthal, George, 85, Queen Victoria-street, E.C.
Southee, Arthur Philip, Mount Edgecumbe, Ramsgate.
Squire, John Barret, Worston-house, Durning-road, Liverpool.
Stanger, George Hurst, Queen's-chambers, North-street, Wolverhampton.
Stone, James Henry, J.P., Cavendish-house, Grosvenor-road, Handsworth, Birmingham.
Tarr, William, 83, Knightrider-street, E.C., and Ferndale, Walton-on-Thames.
Trench, Lieut.-Colonel the Hon. William Le Poer, 3, Hyde-park-gardens, W.
Verity, John, 31, King-street, Covent-garden, W.C.
Warrick, Robert Betson, 27, Woburn-square, W.C.
Weager, W. H., 26, Leadenhall-street, E.C., and Tottenham.
Weir, James, 49, Jamaica-street, Glasgow.
Wells, Charles A., 1, High-street, Lewes, Sussex.
Wing, John Unwin, Brinkburn-grange, Sheffield.
Wyatt, Vitruvius, Gas Light and Coke Company, Beckton, E.
Ziegler, David, 7, Upper Woodland-terrace, New Charlton, Kent.

The Chairman delivered the following—

ADDRESS.

As no doubt most of you are aware, the By-laws of this Society make it necessary for the Chairman of the Council to retire from office after he has served for two years, and render him ineligible for re-assuming the chair until he has been away therefrom for at least one year. And thus it is, that we are deprived of the advantage of the chairmanship of Lord Alfred Churchill, who has so ably discharged, during the last two years, and on previous occasions, the duty of presiding over your Council. I am sure that, expedient as the By-law is, looked upon as a general law, applicable therefore to all, those who fully know, as the members of Council do know, the valuable services Lord Alfred Churchill has rendered to this Society by his assiduous attention to his duties, and by the high intelligence and extreme courtesy which he manifested in the discharge of them, will regret that, in his instance at least, the obligatory retirement enforced by the By-laws could not have been waived, so that we might have been able to say, "Oh, Chairman, reign for ever." Among all the members of this Society, none would have uttered that wish with more earnestness and with more sincerity than the member who now addresses you. But our laws, like those of the Medes and Persians, are inflexible in their application, and so it befel that, at the end of last Session, the chair became vacant.

I have received, from my colleagues on the Council, the unexpected honour of being selected as the successor to Lord Alfred Churchill, and thus it happens I have before me the task of addressing you on the opening evening of the Session 1880-81. I find in the performance of such a duty great difficulty, but being a duty, and one imposed by the By-laws, it must be fulfilled, and I will, therefore, without further preface than that of bespeaking your kind indulgence, proceed to discharge my task.

Your late Chairman, in one of his addresses, reminded you that when, in 1754 (126 years ago), this Society was founded, there existed none other which took cognisance of Arts, Manufactures, and Commerce. The Royal Society, established in 1660, was then, as now, engaged in the cultivation of pure science; and, indeed, it was not until some years after your foundation that Smeaton, the civil engineer, and a Fellow of the Royal Society, finding the need of an institution dealing with the application of science, originated that society of civil engineers now known as the "Smeatonians," a society which, from the first, was devoted to social purposes as well as to the discussion of engineering subjects; it is in the former capacity alone that it at present exists, having for its president of this year the engineer who is now Chairman of your Council.

Very different is the condition of things at this time. Institutions and societies abound on all hands. Indeed, it would be difficult to find a profession, or, in fact, an industry, which has not its own special society, or even, as in the case of the engineer, several societies. Civil engineering, in in its wide and comprehensive aspect, is represented by the Institution of Civil Engineers, but branches of civil engineering have their separate societies—the Mechanical Engineers, the Naval Architects, the Telegraph Engineers, Mining Engineers, and others. Then we have the Institute of Architects, we have the Chemical Society, and more recently the Institute of Chemistry; and, in conclusion of this imperfect abstract of the list of learned societies, we have the comprehensive British Association. Among industrial societies, we have the Iron and Steel Institute, the Royal Agricultural Society, and others, not to speak of Chambers of Commerce. Not only has each profession its special society, but commonly also its own peculiar literature, such as journals devoted to engineering, to architecture, to medicine, and to chemistry. The industries likewise have their special literature; we have such papers as the *Miller*, the *Draper*, the *Jeweller and Metal Worker*, and I am told that there is a journal devoted to the profession or trade —I not know which to call it—of the pawnbroker.

You may remember that a late popular author took exception to the parade of system in the business of the publican, and, complaining of the inscriptions of "wholesale department," "retail department," and "jug and bottle department," suggested that the time would come when the subdivision would be still further extended, so that we should see written up "whisky bell" and "brandy entrance." I must confess I have a somewhat similar apprehension about the multiplication of societies for the consideration of branches of a profession; and I feel the day may come when there will be an institution for the civil engineering of piers, another for lighthouses, a third for docks, and a fourth for iron girder bridges. Up to a certain point, separate societies for branches of a profession, such as that of the Naval Architects, and of other already cited institutions as existing for branches of civil engineering, may be of advantage; but it is easy to carry the system of separation so far as to imperil the acquisition of the general knowledge of his particular profession as a whole, which a thoroughly competent professional man should possess.

But without speculating further as to the future development of special societies, it is clear a sufficient number already exist to give occasion to some among the outside public, who have not been at the pains to consider the subject, to ask what is now the necessity for a Society of Arts? What functions remain to it in relation to Arts, Manufactures, and Commerce? Do not the special societies cover all the ground, and are they not, being special, in a better position to do good work, each in its own line, than can be done by a society like yours, which has no speciality? Such suggestions, adverse to our continued utility, may find favour on a first hearing among those who do not know the working of our Society, and who will not be at the pains to learn what that working is, before they come to a determination in their own minds upon the question, but we, the members, know better. We are aware that there is a very wide field for the work of this Society—a field unoccupied, and of necessity unoccupied, by the special societies which have sprung up. For instance, we must all agree it is for the good of the country at large that men and women, wholly unconnected with particular industries, except (and it is a most important exception) in their capacities of consumers, should have a general knowledge of how those things they consume are produced. I will ask how, without the existence of the Society of Arts or of some kindred society, would it be possible for this large section of the public to obtain such general knowledge. By the hypothesis, these persons are not specialists, and, therefore, they are not eligible as members of these special societies. Moreover, in the comparatively rare cases, where a man is eligible for membership of one society, he cannot be eligible for membership of all; and, further, if a non-specialist attend the meetings of a special society, he will find in all probability that its deliberations are not relating to broad generalities, such as the non-specialist wants to hear discussed, but that they are concerned, and properly so, with considerations of detail—of those details which may appear of but small value to the ordinary hearer, even if he can understand them, but to the patient accumulation of which the improvement in an art is much more commonly due than it is to some one great discovery.

At our meetings, as I have said, the audience profit by having presented to them, in a comprehensive and intelligible form, the leading facts connected with our important industries, thereby the range of knowledge of all is increased and interest is excited; moreover, this very important end is attained, that those who are thus instructed become intelligent purchasers, a desirable result not only for those who purchase, but for those who manufacture, since the intelligence of the purchaser raises the standard of the manufacture. I will refer to a recent instance, that of the admirable course of Cantor Lectures delivered here by Mr. Bolas on the "India-rubber and Gutta-percha Industries." I do not hesitate to affirm that the hundreds who heard those lectures, and the thousands who read them in our *Journal*, became thereby discriminating purchasers, to their own benefit and to the benefit of the honest producer.

At the risk of being open to the charge of quoting myself, in remarks I delivered in this room some years ago, upon the Patent-law, I must point out another, and, to my mind, a very important particular, in which the bringing the processes of manufacture before persons not having any special knowledge thereof is useful, and that is the aid afforded to substantive invention. By substantive invention, I mean an invention which changes fundamentally the process of a manufacture, as distinguished from inventions of improvement in detail in the manufacture as hitherto carried on. Those who are imbued with a specialist's knowledge have a difficulty in taking a thoroughly new view of a manufacture; paradoxical as it is, they are encumbered with their own too intimate knowledge of every existing step and detail. In the paper on the Patent-law, to which I have alluded, I gave certain instances of well-known substantive inventions, all of which had been made by men having no previous connection with the industries to which those inventions related. I will not take up your time by repeating any of them here, but I will, with your permission, give the following instance—an instance that has come to my knowledge since the date of that paper. Fortunately, in the interests alike of the makers and the wearers of boots and shoes, a certain inventor, when he set himself to invent a machine for sewing on the soles of boots and shoes, had no previous knowledge of the manufacture, except that wherein rivets were used. He knew what an ordinary sewing machine was like, and he, of course, knew the outward appearance of a sewn boot. Luckily, as I have said, he had not studied that part of the shoemaker's art which related to the attachment of the sole by sewing. It occurred to this inventor that it would be a very desirable thing if a sewing machine could be made so compact that the necessary working parts could be introduced up the leg of a boot, and to the very extremity of its toe, and, when there, could be driven in the needed and imperative unison with the machinery exterior to the boot. The inventor solved the problem, and made a machine, the necessary portion of which could be inserted into the toe of a boot, and could be worked there, but this machine would not have been of the slightest use in sewing a sole to a boot in the manner in which that operation had up to that time been conducted by hand, although it was of every use in the sewing on of a sole by the process which the inventor, in his happy ignorance, believed to be followed.

In the ordinary hand-made boot, the upper leather is not fastened to the sole directly, but has sewn to it a bevelled strip on each side, which is called the "welt." It is this welt, and not the upper leather, which is united to the sole, and thus, although the hand cannot be got to work within the boot, the union of the upper leather to the sole is effected through the medium of the welt. The inventor, however, considering the whole subject with an untrammelled mind, assumed that the reasonable way to secure the upper leather to the sole was to do so directly, and without any go-between. Now, everybody who knew the art and mystery of shoemaking had a trammelled mind, he had it engrained in his very being, that in all cases where thick and comparatively rigid soles were sewn on, welts were indispensable. I will ask you to imagine to yourselves the impediment that this reverence for the welt must have

been in the way of any man thoroughly understanding the shoemaking business, and endeavouring to use sewing machines for the purpose of attaching the sole to the upper leather. Such a one would get as far as the sewing of the welt to the upper leather by machinery but there he would be stopped from any attempt to devise a machine to work within the boot, and for the very obvious reason, that having sewn on the welt, he would, of course, use that welt for the purpose for which he had sewn it on, namely, that of effecting the union of the upper leather to the sole by stitches, not from within the boot at all, but entirely external thereto. I have seen the evidence which the inventor prepared to offer before the Privy Council, and he there declares that had he known the details of the way in which the upper leather is sewn on to the sole, he would never have ventured to solve the problem. The inventor, of whom I have hitherto been anonymously speaking, is Mr. Blake, an American, and I was informed only yesterday, through the representative of the Blake Company, that one hundred millions of pairs of boots and shoes were sewn last year on the Blake machines. I have devoted, I fear, to the subject of boot-sole sewing machines too large a proportion of the total time allotted for this address; but I have been induced to do so because I believe the circumstances I have narrated afford a fair instance of the benefit which invention derives from the attention of intelligent non-specialists being directed to the broad and general features of a manufacture, in the way in which it is directed in the papers and lectures read and delivered within this room.

Another use of our Society is this—we afford an appreciative home to new arts and industries. The Royal Academy itself, which was founded in 1768, owes its inception to the first exhibition ever made of the pictures of British artists in 1760, and repeated in following years, in the rooms of the Society of Arts. Again, in 1852, photography came to us as a new-born art, and one without a home; that foundling was taken in by the Society of Arts, and, being nourished, has grown up to vigorous manhood. We will hope that invention and discovery are not at an end, and that, from time to time, new arts and industries will arise. As they come into existence, it is all but certain they will need shelter and encouragement, and sure I am that so long as this Society is to the fore, those needs will not remain unsatisfied.

Without taking up your time by further specific instances of the way in which our Society has a right to its place, notwithstanding that there are so many special societies and institutions, I may refer objectors to the answer contained in the old saying, "That there is nothing so successful as success," and if they dared to dispute our being successful, they would certainly be defeated. We can point to the fact that we number over three thousand members, that we have institutions all over the country in union with us, that we publish a weekly *Journal*, circulated gratuitously among those members and institutions, by which they and the public at large are kept fully informed of the condition and progress of our leading manufactures, that we have been fortunate enough to be favoured with the recognition of the Prince of Wales, who honours us by being our President, and that we succeed in obtaining in the guidance of our work the untiring assistance at the Council of men eminent in the most varied ways.

With respect to the work we do, some of our critics say that we occasionally, indeed not unfrequently, occupy ourselves with matters which, wide as is the scope of the Society's operations, as stated in our Charter, cannot be brought properly within the pale of Arts, Manufactures, or Commerce. For instance, the Society takes up Drill. They say if drill mean a certain textile fabric commonly used for male garments, well and good; if it mean the implement for making holes, either in the soil or in metals, equally well and equally good; but if it mean, as in truth it does, the training to which soldiers are subjected, how, by any possibility, can that drill be connected with arts, manufactures, or commerce? What have "shoulder arms," to do with arts? "Right about face," with manufactures, or "quick march," with commerce? "Shoulder arms" suggests hard angularity, and nothing in connection with arts, or art; "Right about face" is opposed to the steady and forward progress that should be made in manufactures; and "Quick march" is more applicable to mere speculation, than to the sound prosecution and regular progression of legitimate commerce. Apparently valid objections these, but see how they disappear before the explanation given by the advocates of drill. They say, to have excellent manufactures, you must have excellent workmen—you must cultivate not only their minds, but also their bodies. You want manly men, men whose powers are developed, and who are trained to apply those developed powers in the best manner. An excellent means to this end is in early life to give the training of drill, resulting in that which we all know as a soldierly bearing; a lad who has once acquired this will hardly ever in after life entirely lose it, but he will go about erect, self-reliant, and self-respecting, and for the whole of his life will be a better man than one who, undrilled, slouches through existence. Should the critics still be dissatisfied, and say the link you show between drill and manufactures is too slender, the argument is more ingenious than sound, and should they urge that public bodies ought to keep more rigidly to the undoubted objects for which they were incorporated, the supporters of drill can refer to a precedent of very high authority—a precedent which, with your permission, I will quote to you. In a certain island, the latitude of which I will not state, and the longitude of which I cannot state, because to the English mind it is of no longitude, there were established in years gone by, three principal Courts of law, the names of which, curiously enough, may be not unfamiliar to you. The first was called the King's Bench; it took cognisance of affairs affecting the dignity and peace of their lord, the king. The second was called the Court of Exchequer. This Court took cognisance of all matters affecting the king's revenue. The third Court was called the Common Pleas, and it took cognisance of plaints between subject and subject. While the population was scanty and rude, business transactions were but few, and the Court of Common Pleas was the least occupied of the three; but, as time went

on, the people increased in number and in wealth, and became more civilised. Offences against the king's peace, and frauds upon his revenue, happily for the public, diminished in number, while business developed, and, as a result, transactions became complicated, and plaints between subject and subject grew and multiplied. The Court of Common Pleas naturally was in a very flourishing condition, and those connected with it throve upon the fees paid by the suitors; but the Courts of King's Bench and Exchequer, although they retained their dignity, found themselves excluded from the pecuniary benefits enjoyed by the Common Pleas. This went on until an ingenious member of the Court of Exchequer, prompted by necessity, found the connecting link by which that Court was enabled, of course strictly within its functions of guarding the king's revenue, to take cognisance of plaints between subject and subject. The link was this. Subject A should pay the king his taxes, but if subject B did not pay to A the money which B owed to him, A obviously would not be likely to pay the taxes to the king, thereupon, quite within its province of course, it became incumbent on the Court of Exchequer to ascertain whether B did owe A a sum of money, and thus the Court of Exchequer investigated plaints between subject and subject. The unhappy King's Bench, however, was still left out in the cold, a cold by comparison all the more disagreeable to bear because its colleague, the Court of Exchequer, had succeeded in withdrawing itself into a comfortable shelter. At length the genius needful to supply the connecting link for the Court of King's Bench was found. That Court, you will remember, took cognisance of all matters affecting the king's dignity and peace. Said the ingenious man of the Court of King's Bench, I know nothing much more likely to cause a breach of the peace than the refusal to pay a just debt. If B owes A money, but will not pay A, such is the infirmity of human nature that A is very likely to cudgel B at the first convenient opportunity. To prevent this breach of the King's peace, it is clearly the duty of the Court of King's Bench, and strictly within its functions, of course, to take cognisance of the plaint between subject A and subject B. Whether this tale is a strictly true one, or whether it has only a foundation of truth, and that as regards its details the Islander from whom I received it was imposing on my credulity, I won't pretend to say, but it seemed to me not wholly inapplicable to the subject we were considering, and that the advocates in the Society of Arts for the promotion of drill, if they can't convince by their argument, may, at all events, crush their opponents by the weight of the precedent I have just quoted.

Having regard to the undoubtedly wide scope afforded us by our Charter, and to the probable increase of that width by ingenious reasoning and by precedent such as I have cited, you can well understand that there are very few subjects indeed in respect of which a connection with the purposes of this Society may not be traced, or, at least, imagined; and thus it is that your Council have to exercise great discrimination in the acceptance or non-acceptance of the various suggestions that are made to it, as affording proper subjects for the action of the Society. Brown would have all our energies devoted to the obtaining of a soft water supply for the kingdom at large; millions of money would be saved in soap, and millions more in tea. Jones is convinced that water supply is indeed the only fit subject for the Society, but urges that the water must be hard if we desire to avoid lead poisoning—if we wish for a delicate cup of tea instead of a dark and bitter family brew, and above all, if we desire to see the rising generation furnished with bones, and are not content that they should be simply cartilaginous animals. Robinson believes that the true present work of the Society is to see that all sewage is disposed of by irrigation; while Smith, although agreeing that the disposal of the sewage is the only true work, is clear that irrigation is but another name for the spread of disease, and that salvation lies in precipitation. Others would have the Society neglect everything until it had achieved the introduction of the decimal system, and of the French metrical system in particular. Government must come to the rescue. Decimals must be obligatory. They would have no half measures; I beg their pardon, no nought decimal five measures; they would show no quarter—again I err from the right way, I mean, of course, no nought decimal two five—to those who dare to use that complex term, one-third, instead of the simple and nearly accurate expression, nought decimal three three three and a little dash in the right-hand corner; still less would they forgive those who employ, in describing the division of anything into seven equal parts, the wholly unintelligible and cumbrous one-seventh, instead of the concise and elegant (and again nearly accurate) nought decimal one four two eight five seven, and again the little dash in the right-hand corner. The foregoing are but instances—instances of demands which may come from the outside public, from the members of the Society, or, I speak it with reverence, even from the members of the Council itself. Probably some of us have now, as people had in Mr. Shandy's time, our little hobbies on which we would fain disport ourselves; but, happily for the Society, we are not allowed to do so, unless the hobby is proved to be discreet and trustworthy. The check to our vagaries is this: our Council, as I have told you, is composed of men of varied pursuits, the soldier, the legislator, the sailor, the engineer, the chemist, the physician, the Government official, the potter—emphatically *the* potter, for I allude to our friend Mr. Doulton, to whom we owe a new art industry, of which England is justly proud—and many others, go to make up your Council. And though, as I have said, some of these, including, it may be, their chairman, have each his own little hobby, in the sure-footedness of which he implicitly believes, he is not thereby rendered incapable of perceiving the defects in his neighbour's favourite steed. All banter apart, your Council is well attended by men of divers qualifications, and no plan brought before that Council is made the subject of the action of the Society, unless the plan, after thorough scrutiny, commends itself to the good opinion of the majority. Care has also to be exercised in the acceptance of papers, to ensure that not only shall the subjects be of sufficient interest in themselves, but that they are free from any

suspicion of partisanship, or of trade puff. In this work, as indeed in all other matters, the Council are greatly aided by our most attentive and careful secretary, Mr. Trueman Wood, whose connection with this Society, first as assistant secretary to our late and valued friend Mr. Le Neve Foster, and since his death, as secretary, has now subsisted for eight years. On the whole, looking at the innumerable temptations there are to stray, I think the Society is to be congratulated on having kept very fairly within its proper boundaries, and I know I am safe in assuring you that no pains will be spared by your Council, nor will any amount of time and attention be grudged to ensure that good and useful work shall continue to be done.

Thus far, I have been reviewing some of the past action of the Society, and, in doing so, I have have had of necessity to bring to my own recollection the nature of many propositions laid before the Council by ardent persons, but properly rejected as being visionary, or as not within our true functions. And such recollections have tempted me here and there to stray too far from the sedateness that has characterised, and that some of you will think ought always to characterise, the annual address. I fear it will be said that if there be some grains of valuable truth to be found in that which I have laid before you, these grains are very deeply concealed beneath the husk, not to say chaff, with which they are intermingled and overlaid. In considering, however, the future work of the Society which I am now about to do, I find no temptation thus to stray from strict decorum, because I feel that to that future work we ought to devote our best efforts and most grave attention, and because I have to bring before your notice much that is painful and humiliating.

However laudable are those efforts of the Society for the promotion of subjects which have not an immediate, but only a remote bearing on the welfare of Arts, Manufactures, and Commerce, I, for one, am better pleased when I find we are occupied with subjects which do undoubtedly directly and obviously bear upon that welfare; and I am sorry to say that there is an ample field for such occupation in the present condition of our manufactures.

Many of you have, no doubt, read the address delivered at the summer meeting of the Mechanical Engineers by the President, Mr. E. A. Cowper. In that address, Mr. Cowper gives instances of the way in which foreigners not only compete, and rival the manufacturers of this country, but surpass them and outstrip them, and it is to this question I desire now to direct our thought. I am aware this is not a pleasant subject. I should have been glad indeed, if, on the first night of our Session, I could have followed many of my predecessors, by talking to you of progress and of success. Depend upon it, it is more agreeable to the occupant of this chair to prophesy pleasant things, than it is to prophesy evil things, but, nevertheless, there can be no doubt which of these two courses is that of duty, and that course, and not the other, is the one that must be followed.

With respect to this question of being beaten by our rivals, very varying feelings are excited as we consider the circumstances attendant upon our defeat in each particular case; for instance, we do not even regret that an industry, which is an exotic, and not natural to the country, fails us, and reverts to its more proper home. As an extreme example, it is recorded that, long ago, it is true, wine was made from a vineyard on Tower-hill. No one, I presume, seriously laments that efforts have not been made to continue such an industry as this in England. We are well content that it should depart to countries possessing a more genial climate than that in which we live.

We do regret, and complain, but we do not feel ashamed, when an industry, properly within our province, is caused to wither by the mistaken action of the Government of another country, in pampering such an industry within that country by bounties and premiums, against which our manufacturers cannot contend. We are not ashamed of being beaten under these circumstances, but do our best by protest, and, by all means short of a retaliative duty, to put a stop to so mischievous a procedure. But we lament, and that with a mixture of shame, when we find that, in the absence of any such adverse influence as that arising from bounties in foreign countries, industries which are thoroughly adapted to the climate and the soil, and, worse than this, industries which should, from our natural advantages, be specially our own, are carried on in foreign countries in a manner not only to rival us in these countries themselves, and in the markets abroad, but so as actually to successfully compete with us on our own shores. Surely in iron and in steel manufacture, intimately connected as the success of these manufactures is with the cheapness of fuel, we ought to be able to defy competition in any open market, and yet we know that large quantities of girder iron are habitually imported into this country from Belgium. This importation of iron from Belgium is but one instance; it is, I regret to say, by no means a solitary one. Surely there must be something wrong in our conduct of manufacture, when such a state of things can exist, and I believe the Society of Arts will do well to endeavour to ascertain what this something wrong is, and having ascertained, it will do well to set itself to endeavour to find a remedy for the wrong.

I will not venture to predict what would be the result of investigation into the causes of this condition of things, but one can imagine we shall find higher rates of wages operating in some cases, but certainly not operating in those instances where we are beaten out of our own markets by American manufacturers, for in that country, undoubtedly, wages are higher, as a rule, than they are with us, and there are three thousand miles of transport needed to bring the manufactured article to our doors. We shall find, it may be, that many of our industries are carried on according to the old traditions, traditions of practices which were the best known in the days when they were first employed, but which, under the teaching of science in other countries, have been abandoned as obsolete, while they are retained by ourselves. We may find, paradoxical as it appears, that the fact of our having been engaged in any particular manufacture for many years obstructs our readily adopting the most improved forms of carrying on that manufacture, and obstructs it, for I am again about to quote myself, in a way that I pointed out when speaking on the question

of Patent-laws. Let me state it to you. Imagine a manufacture demanding a very heavy investment of capital in plant, and imagine that investment made a quarter of a century ago by the acquisition of plant which was the best then known. Then assume that some other country has recently taken to the particular manufacture, and has done so with the benefit of all the experience gained in our country and elsewhere, and with the ability, therefore, to adopt only that which is known to be good, and to reject that which was wrong and has become obsolete. Such a manufacture newly started in a country gives, therefore, to those who pursue it, the advantage of expending their capital upon the newest and best plant by which to carry on the manufacture, and upon that plant alone, while those who have carried it on for years in our own country cannot put themselves on a par to compete with their new rivals, unless they are prepared to abandon the whole of the capital which has been embarked in plant, which must become obsolete, if the new processes are to be adopted. This is a serious sacrifice to face; few have the means to effectually face it, and those who have, very naturally feel disposed rather to retire from an industry which, for its successful pursuit, requires to be in effect begun anew, and even to be learnt anew, than to invest their savings in the necessary plant for this new manufacture.

It may be there will be found, and I fear there will be found, but I do trust in only a few instances, that we have lost command of foreign markets, and even of our own markets, because in these instances the manufactures have not been honest. There was a time, when travelling on the Continent, one was proud to see English manufactures put forward as those to be thoroughly trusted. A foreigner felt that if he bought an article of English make, though it might not be tasteful, at all events it would be what it purported to be, sound, honest, and trustworthy. I am afraid we cannot now say so of all that is exported from our country, or that is offered for sale within it. I do hope we can say so of most of our manufactures, but we certainly cannot say it of all. But it should be remembered as against those who commit this grievous wrong of casting a slur on the character of any of our industries that they not only do harm to the particular manufacture with which they are connected, but they do harm to the character of the whole produce of the nation. A man who has been trapped into buying a bad English product of one kind, is not at the pains to ascertain whether the badness is confined to this particular manufacture, and in all probability he has not the means of ascertaining, but he says, "I bought an article which came from America, and I found it good, sound, and trustworthy. I bought a similar article that came from England, and it broke in fair use, and when it broke, its internal rottenness was discovered. In future, not only with regard to this article, but with regard to others, I shall distrust the English make, and shall prefer the American."

In connection with this most painful subject of unfair dealing, to my mind, there is nothing more humiliating than the confession of widespread dishonesty which the nation had to make some few years since, when, for mere self preservation, it became necessary to pass an Act of Parliament, directing the appointment of public analysts. The passing of this Act was a confession that, among those who supply food, which is to support life and to preserve the health of those who are in health, and worse even than this, if possible, that among those who supply the very drugs which the physician prescribes to restore health to those who have lost it, there were to be found numbers who made the food and the drugs alike the subjects of fraud—fraud that did not stop short at the mixing with the food or with the drugs materials which were inert, and which did harm by diminishing the nourishing or the curative power of that which was purchased, but fraud which extended to the mingling, in some instances, of materials which were, in themselves, actively unwholesome, materials which, being taken with the food, converted the food into a source of disease, and being taken as curative drugs, converted those drugs into positive poisons.

Is it not too much to be feared that, in some industries, at all events, that reprehensible conduct which has rendered necessary the appointment of public analysts to protect the population of this country, has been the guide of certain of the manufacturers, and has thereby caused us to export that which is a fraud upon the foreign buyer, and a discredit and an injury to the country that exports.

I had intended to refrain from instances, but I will endeavour, in general terms, to state one which relates to a very large industry. It appears that in a certain manufacture the purchasers preferred to buy goods that were dyed in one stage of the process rather than in another, as the goods thus dyed were supposed to be better, and they naturally, therefore, commanded a higher price. The finished goods bore on themselves indications which enabled any purchaser, at all acquainted with the manufacture, to determine at a glance in which of the two ways the article offered to him had been dyed. Then came the deceit. Means were adopted by which the appearance that would have been presented, but for these means, upon the material dyed in the undesirable way, was concealed, so that the appearance really presented was that which would be shown by the manufacture when dyed in the desirable way. It is true that experts in the trade can, after the deceit has been employed, distinguish the one fabric from the other, but the ordinary buyer living abroad, and not suspecting the fraudulent ingenuity that had been exercised in England, and seeing, as he believes, the well-known appearance indicative of the superior mode of dyeing, is deceived, and pays a higher price than he would have paid had he known the truth. It cannot be urged in explanation that this contrivance was resorted to because the appearance presented by the one fabric when in use was superior to that presented by the other. This was not so, as the part of the fabric that was thus treated was the very edge, and was cut off before the fabric was used.

You must not imagine that this deception was practised by a few, or to a limited extent. So far from this being the case, it became worth while to invent machines to supersede the handicraft preparations by which the deception had been originally practised, and these machines were patented. I need not say that such patents are

voidable, as being against public policy, their purpose being that of fraud. I am aware I shall be told these are hard remarks to make upon a practice which has now prevailed for years, and to such an extent as to entitle one to say—"It is commonly done. Everybody does it. Why, therefore, reproach us with that which is a custom of the trade?" I answer, "Because it is a custom for the purpose of deceit."

With respect to commerce, I do not know much about the way in which it is carried on, but I cannot help seeing the statements which appear in the public press from time to time, and if these are well founded, and that they are, cannot, I think, be doubted, looking at the fact that they are not contradicted, it would appear that commerce is pursued, in certain instances, under conditions which, equally with those of the manufactures I have been condemning, are a fraud and a disgrace. I will refer you to an extract from the *Times*, of only three weeks ago. It runs as follows:—

"Alleged Commercial Frauds.—At the meeting of the Liverpool Chamber of Commerce yesterday, a letter was read from Messrs. Alexander, Sparrow, and Co., of that City, stating that they had recently been asked to declare tin plates, shipped to Havannah at one-fifth their true weight. The letter added, 'We are now executing an order for a Birmingham firm, who tell us that they had similar instructions, and, as they have refused, their buyer has made arrangements for all goods they supply to be delivered to a house here which is prepared to make the required declaration. We were told to-day by another metal firm here, that they have been asked to declare tin plates at one-fourth their true weight. Silks are packed in barrels and declared as bottled beer, and tin plates, packed together five in a box, each of 1 cwt., are declared at 1 cwt., instead of 5 cwt., and those shippers and those steamship agents, who refuse to be parties to this sort of thing lose the business.' Messrs. Jevons and Co., write in reference to the proposed conclusion of a commercial treaty with Spain:—'We are extremely pleased to hear of the intention of the Government, believing that the high scale of duties levied upon English goods in Spanish ports is demoralising to all concerned, leading to false description of goods, false packing, and false declaration of weights. It is no secret that such devices for evading the duty are more frequently the rule than the exception, and the business, as a matter of course, falls into the hands of those houses which lend themselves to such deception.'"

The shipowners and others who refuse to accede to such improper demands are honest men, and the consequence is that they lose the business, which goes to others who are less scrupulous. What certainty is there that, after a time, these very shipowners, who refuse to undertake such business now, may not find that if they continue their refusal they will be ruined, because, unless checked by prosecution or by public opinion, the practice will go on until it reaches the stage when, according to the opinion of trade, it becomes legitimate. Men say, "It is commonly done. Everybody does it." And when once that phrase can be applied to any wrongful act, no matter what, it salves the consciences of those who practice the wrong, and then all combat on the part of the honest dealer becomes practically impossible.

Referring to the causes of our being distanced by foreign competition, and especially by American, it may be that investigation will show that a part of our defeat is due to the way in which we receive and deal with inventors and inventions.

I hardly like to approach this subject at all, because on previous occasions I have, through the kindness of the Society, been allowed to occupy many hours of their time in putting forward my views upon it, and in combatting the views of others, but I am nevertheless tempted to ask you to bear with me while I say a few words upon the question, because I most earnestly and sincerely believe in its importance in relation to manufactures, and because I trust there is to be gathered a hope of a change for the better in public opinion concerning it. From a statement appearing in the *Times* of the 12th inst., there is good reason to hope that the President of the Board of Trade is himself desirous of an improvement in the laws. The paragraph is as follows:—

"Mr. Chamberlain and the Patent Laws.—A communication on this subject has been addressed by a gentleman in the North of England to the President of the Board of Trade, whose secretary, in his reply, alluding to a recent speech of Mr. Chamberlain's, says: —'I am desired to call your attention to the fact that he (Mr. Chamberlain) was not in a position to promise the amendment of the law, as the possibility of doing this depends upon the condition of public business, and upon the character and extent of the opposition with which the proposals of the Government may be met in the House of Commons. Mr. Chamberlain hopes, however, that time may be found before long for the consideration of the subject, and, as far as his personal opinion goes, it is strongly in favour of removing or lessening the obstacles which now interfere with and discourage invention in this country.'"

Before any real good can be attained by altering the Patent-laws, it is necessary that those who are charged with the framing of the alteration should consider the question of patents in a totally different light from that in which, in times past, and nearly up to the present time, that question has been considered. Hitherto the framer of a Patent Bill was expected to prepare it on the supposition that on the one side were the public, and on the other the enemy of the public, the inventor, against whom the public, by the ingenuity of the framer of the Bill were to be protected. I submit the true spirit in which the revision of the Patent-laws should be approached is to understand that, on one and the same side, and not in opposition, are the public and the inventor, and that the object of the new law should be to afford that protection to both which would result in benefit to the public and in a fair reward to the inventor.

The popular impression is (I wish I could say "was") that directly an invention connected with an industry is published, all engaged in that industry would use the invention, and thus the manufacture, and through it the population at large, would benefit, were it not that this benefit is delayed for fourteen years because of the patent protection given to the inventor. But the truth is, that so far from manufacturers desiring to adopt an improvement, they would desire nothing better than that their manufacture should have reached the point where improvement is impossible, and where they could sit down and say, "we are up to the very acme of perfection in all our plant and machinery, and in our knowledge of the business. We have no change to apprehend. We can carry our works on as a set trade, and we

need not fear that our capital embarked in plant and machinery will have to be written off, and that further capital will need to be expended in providing fresh plant of a different character, the use of which we shall have to learn." This reluctance to adopt inventions is the fact. I do not complain of it; it is human nature. There is nothing dishonest about it. To combat this natural disinclination to adopt novel improvements, I know of no means, except the giving to some one person, the patentee, a strong interest. As a matter of fact, it commonly requires a patentee to devote several years of his time, and to incur a large expenditure of his money, before he can succeed in getting his invention into commercial use, that is—before (as has been somewhat coarsely but most expressively said), the inventor can succeed in thrusting the invention down the throats of the manufacturers.

As very pertinent to this subject, I will ask you to read a letter from Mr. A. Barff, published in the *Journal* of the 3rd of September last. Mr. Barff is answering the letter of an inquirer as to why liquid fuel is not used in steam vessels. Mr. Barff enters very fully into the subject, shows the success that has attended the trials, shows the advantages that would result from the adoption, and then, at the close of his letter, gives his reason why the liquid fuel is not used; and this reasoning proves that Mr. Barff, at all events, is aware of the need that there should be some person having a strong interest in the development of a new system or process, for he says (in effect) the reason why liquid fuel is not used in steamers is that, having regard to the length of time during which the employment of such fuel has been under public experiment, no opening for a valid patent remains, and thus it is no one's interest to push that employment. It never occurs to Mr. Barff for a moment that he is making a statement opposed to the popular, but erroneous notion that the use of an invention is checked by its being the property of some patentee; on the contrary, he puts forth the truth, so well-known by those who have studied the subject, that where an invention is open to all, no one cares to touch it. I must once more quote, in support of Mr. Barff, the witty but sound statement made by Dr. Siemens in this room, that if an invention were found lying in the gutter, it would be to the interest of the public that some person should be appointed its owner.

These facts, as regards the value to the public of giving the inventor an interest in his invention, are well known to Dr. Siemens, to Mr. Barff, to myself, and, in fact, to all engaged in industrial pursuits, or in application of science to those pursuits. But unhappily, for some reason, I know not what, certainly not on account of the amount of litigation in connection with patents (for that is extremely small), the preparation of a Patent Bill is not left to persons who are well acquainted with those things, but is left to some high legal official who, if he knows anything about the working of inventions at all, knows of them only in their exceptional condition, that of litigation, and who is imbued with the old idea that the inventor is the enemy of the public, and should be curbed and checked. Further, this mistaken zeal in the interest of the public causes our Patent-laws to be suspicious of foreign inventions. I am quite clear that, in the interests of our industries, we should do all that we can to attract foreign invention to our country. Depend upon it that, when a foreign invention is a good one, we have to elect whether it shall be introduced and worked here, or whether we will quietly sit by and see our industry to which that invention relates beaten out of the field by the importation from abroad of superior or cheaper articles made under the invention we have scouted.

No one holds the law and its high officers in greater respect than I do, but I cannot refrain from expressing my earnest desire that any Patent Bill which is brought forward may, as regards essentials, be prepared by those who know, from practical experience, the real working of patents for inventions, and that the aid of the lawyer should only be solicited to take care that those essentials are properly set forth. If a Bill thus prepared were passed, we should, I believe, get rid of all the defects which now disfigure our Patent-law.

I commenced this part of my address, by saying that it would contain matter which demanded every gravity in its treatment, and matter that was not of a pleasant character to listen to, and thus far I fear I have only too thoroughly adhered to my statement. Let us see, however, if we cannot, before we separate, find some brighter prospect to regard. Let us see whether it may not be possible for this Society to devote itself to the cure of some of these evils.

As regards the question of frauds, I am sure the Council, as prudent guardians of the interests of the Society, will not dare to advise that we should emulate the conduct of the *Lancet*, the proprietors of which journal, in years gone by, fearlessly exposed frauds of adulteration, not only as regards the nature of the adulteration, but as regards the names of those who were guilty of the misconduct. This, as I have said, is a work that we dare not undertake; but it appears to me that the Society might most usefully investigate into any suspected industry, to ascertain whether there are any, and if so what, fraudulent practices carried on in that industry; that they might then obtain samples of the true and of the false products, might exhibit those samples side by side in these rooms, for the inspection of all, and might, in their *Journal*, give such descriptions as were possible by word and by engraving, so as, both by the samples exhibited and by the descriptions given, to instruct the purchaser and to enable him to avoid the dishonest production. This was what I had in my mind when, at an earlier part of the address, I said that it was to the benefit of the honest producer that the purchaser should be instructed in the nature of the article that he purchases.

Where the outstripping by foreign competitors arises from other of the suggested causes, the Society, it seems to me, may also do useful work. Why should it not put itself in communication with the manufacturers in some industry which is suffering its hold on foreign markets, and, it may be, even its hold upon the home market, to be interfered with by the foreigner, to ascertain from these manufacturers whether the competition against them is succeeding on the score of

price, or on that of quality, or on the score of the higher knowledge possessed, or the better taste displayed abroad. If it be on account of price, let us find out whether the disparity arises principally from the labour question, or whether it arises, as it must do in countries where labour is dearer than in ours, from the use of improved processes in those countries—processes which we have failed to employ.

Again, where we find that the cause of our defeat really does lie in difference of wages, let us see whether it be not possible to improve the application of machinery to such a point as shall render the wages question unimportant compared with other considerations which may be in our favour.

I have sufficient confidence in the skill and ability, and in the amount of capital available in this country, to believe it needs only that the true causes of the success of our competitors should be discovered to make us effectually bestir ourselves to restore the threatened industry to its former safe position.

If we find the superiority of the foreigner to be due to the judicious encouragement and adoption of invention, then I trust that matter will ere long be set right by the promulgation of new Patent-laws, framed on sound principles.

I have hitherto spoken of those industries wherein successful competition has already seriously affected us. But there are others, of course many others, in which we still hold our own, and hold it well. Among these is that of the "carrying trade." No one can read the records which from time to time appear in the papers, of the magnificent steamers which are being built, and year by year are increasing in size and carrying capacity, without feeling a sense of gratification, that on the sea, at all events, England is holding, as she ought to hold, her own. You will have noticed that these steamers have long since ceased to be built of wood, and that iron has been the material employed. You will also have noticed that now gradually, although very gradually, iron is being superseded by steel. It may not be generally known to you, but it is the fact that the United States are now producing enormous quantities of Bessemer steel. The Americans, it need not be said, are hardy mariners, they are daring naval architects, and it only remains for them to have money a little cheaper (and it is becoming cheaper day by day), and to get rid of some of their own restrictive duties, to enable them to apply a portion of this surplus steel to the building of steamers which will enter into competition with our own. Depend upon it, that when such rival steamers are started, every invention tending to economical management and working, and especially, therefore, to the saving of fuel, will be adopted in their ships. And thus it behoves our shipowners and merchants (as well as our manufacturers) to watch all improvements as they are brought forward, to adopt them if sound, and not to wait until the adoption is forced on them, because they find their rivals have already used the improvements, and are thereby enabled to obtain a preference in the ports to which they trade.

I suggested it might be found that a cause of successful competition against us in certain manufactures, arose from a want of knowledge or from a want of taste in those engaged in the same manufacture in our own country. I do not mean the mere rule of thumb knowledge, but the knowledge of the scientific principles involved; and upon this point, although I feel I have trespassed on you at too great a length, I will ask your indulgence for a short time—a very short time. I am one of those who believe that for a manufacture to be carried on successfully under all circumstances of change which may arise, those engaged in it, the principals, managers, foremen, and leading workmen should have a knowledge of the scientific or artistic principles involved in the carrying on of that manufacture. The Society of Arts has long entertained these opinions, and is to be commended for having, in furtherance of them, in the year 1872, established those Technological Examinations, which it adopted in the absence of any machinery for technical teaching to lead persons to educate themselves, so that they might come forward and submit to an examination by competent examiners, and thereby prove their fitness for the position that they occupy.

These examinations were continued until they became a heavy burden upon the resources of the Society, and their utility having been thoroughly established, they were in the condition in which the Society could properly hand them over to any other body competent to undertake them. As most of you are aware, about two years ago, certain of the Livery Companies of London associated themselves together and established the City and Guilds of London Institute for the Advancement of Technical Education. That institute, which was duly incorporated on the 9th of July last, has, amongst its other works, taken over—now for two years—the Technological Examinations of the Society of Arts. In the outset, the institute was aided in the carrying out of this work, by the counsels of your Secretary, Mr. H. Trueman Wood. The result of the two years' working, has been of the most gratifying character. In 1879, there were in all 202 candidates examined in 7 industries, of whom 151 passed in some one of the grades. In this year there were examinations in as many as 24 industries, and in these 816 candidates were examined, and 515 passed in the various grades.

The City and Guilds Institute is carrying on—I wont detain you with the details of what it is doing—technical instruction in many other ways. It has schools of applied art at Kennington, and applied science classes at Finsbury, where it is preparing to erect a building, at a cost of £20,000, to afford more room for its operations. It has contributed towards chairs of fine art, applied mechanism, applied chemistry and metallurgy, in King's College, and in the University College, London. It has helped the Artisans' Institute, it has helped the Society for the Employment of Women, and it has assisted other educational bodies in the country. Moreover, it has obtained a lease of ground for 999 years, at a nominal rent, from her Majesty's Commissioners of 1851, on which there is about to be erected a central institution, from the designs of Mr. Waterhouse, the eminent architect.

During the autumn vacation, I paid a visit to the Polytechnic Institution at Zurich, established in pursuance of a law passed in 1854. I found there a building of about 445 ft. long by

280 ft. wide, with a central court-yard. I was told that this building, containing, as it is stated, about $2\frac{1}{2}$ million cubic feet of available space, had cost (including two small detached buildings) 2,477,971 francs, or practically £100,000 sterling. In it are taught between 900 and 1,000 students, among whom I found, by the returns, that there is the large proportion of 349 from countries other than Switzerland, and included in these Great Britain figures for 5 students. This establishment is kept up at a cost of 455,000 francs, or £18,200 sterling a year. Of the revenue, which is slightly in excess of the expenditure, about £3,800 is derived from students' fees, at 100 francs per head per annum (except in certain cases, where the instruction is quite gratuitous); £13,800 comes from the State, £800 from the Canton of Zurich and from the town of Zurich, and about £120 from sundry receipts. I felt, I must confess, thoroughly ashamed that a comparatively poor country like Switzerland, having a total population, according to the last census, of considerably less than three millions, should possess an institution of this magnitude, while in England it is difficult to point to the existence of any such institution at all, and while, twenty-five years after the example was set us in Switzerland, we are about to establish in London, at last, a central institution which, whether we regard the magnitude of the building, the number of scholars, or the number of subjects to be taught, will represent but a fraction of the one at Zurich. But, nevertheless, a small beginning is better than no beginning at all. I have great confidence in the result of this attempt on the part of the City and Guilds of London Institute. We have hard-working men on its governing body, among whom are to be found, I rejoice to say, the President of the Royal Society, the President of the Institution of Civil Engineers, the President of the Chemical Society, and the Chairman of the Council of the Society of Arts. Unhappily, in the present instance, the City and Guilds of London Institute do not possess in this last-named official an extra adviser, because it so happens that your present Chairman of Council is also the Chairman of the Executive Committee of the City and Guilds of London Institute. In fact, when it was resolved to ask the advice and assistance of the Chairman of your Council, Lord Alfred Churchill was in office, but before the City and Guilds Institute was incorporated, and had got into actual operation, Lord Alfred Churchill ceased to reign, and I came in his stead, so that the City and Guilds of London Institute have after all proved themselves (as was to be expected) but cockney sportsmen, for they have shot at a pigeon and they have brought down a crow.

I fear I am lapsing into that unseemly levity in which I indulged in the early part of this evening; and on that ground, even if not on the ground of the lateness of the hour at which we have arrived, it is expedient I should bring my address to a conclusion, and I cannot more fitly do so than by thanking you for the attention with which you have been good enough to listen to it, and by once more promising, in the name of the Council, whose chairman I have the honour to be, that every effort shall be made throughout the coming session, as it has been made in times past, to promote the interests of the Arts, Manufactures, and Commerce of Great Britain, and thereby to promote the interests and welfare of this Society.

Lord Alfred S. Churchill proposed a vote of thanks to the Chairman for his excellent address, which contained a most luminous statement of the aims and objects of the Society; and he thought the members must congratulate themselves that so distinguished a man held the position of Chairman of Council.

Mr. W. Botly, in seconding the motion, remarked on the interesting programme prepared for the coming Session, and alluded to the long list of candidates proposed for election. He thought they might all help in promoting the objects of the Society by obtaining new members for what he considered one of the most instructive institutions in existence.

Sir Antonio Brady supported the motion, and, as President of the Inventors' Institute, expressed his particular approval of that part of the address relating to the improvement of the Patent-law.

The vote was carried unanimously.

The Chairman then presented the following medals and prizes, awarded during the past session:—

The Society's Silver Medal:—

To Major-General H. Y. D. Scott, C.B., F.R.S., for his paper on "Suggestions for dealing with the Sewage of London."

To A. J. Ellis, F.R.S., for his paper on "The History of Musical Pitch."

To John Sparkes, for his paper on "Recent Advances in the Production of Lambeth Art Pottery."

To Henry B. Wheatley, F.S.A., for his paper on "The History and Art of Bookbinding."

To W. Holman Hunt, for his paper on "The Present System of Obtaining Materials in use by Artist Painters, as compared with that of the Old Masters."

To Thomas Fletcher, for his paper on "Recent Improvements in Gas Furnaces for Domestic and Laboratory Purposes."

To John C. Morton, for his paper on "The Last Forty Years of Agricultural Experience."

To Prof. Heaton, F.C.S., for his paper on "Balmain's Luminous Paint."

To Captain Abney, R.E., F.R.S., for his paper on "Recent Advances in the Science of Photography."

To J. W. Wood, for his Leak Stopper for the Protection of Ships from Sinking.

His Royal Highness the Prince Consort's Prize of Twenty-five Guineas, to William Clarke Hudson, aged 25, of the Liverpool Institute, student, who has obtained the following First Class Certificates at the Society's Examinations, held in the present and three preceding years:—

1877. Book-keeping.
,, Political Economy, with the Third Prize.
,, English, with the First Prize.
1878. Clothing.
,, Health.
,, Cookery.
,, Housekeeping, with the First Prize.
1879. French.
1880. Commercial Geography and History.
,, Arithmetic.

The Council Prize (for Female Candidates) of Ten Guineas:—To Jannet Lucy Mungeam, aged 37, of the Birkbeck Institution, no occupation stated, who has obtained the following First Class Certificates at the Society's Examinations during the specified period:—

1878. Clothing, with the First Prize.
1879. Commercial Geography and History.
,, Cookery, with the second Prize.
1880. Housekeeping and Thrift.

MISCELLANEOUS.

HOUSE-DRAINAGE TESTS.

The Sanitary Section of the Society of Arts have had before them several tests for house-drainage work proposed by specialists. The methods employed by Messrs. Eassie, Rogers Field, and Griffith are set forth in the report of the meeting of the Section, held June 14, 1880. A report from the Board of Health of Boston has since been received, which gives the following account of a mode of testing house-drains, which has been successfully carried out in that city:—

"It is generally known that leaky house-drains are commonly detected by using peppermint, though just how this is done is not so thoroughly understood. Peppermint is not indispensable. Any of the volatile essential oils will answer as well; but, from its cheapness, peppermint is usually employed. It is put up in small vials for the purpose, one vial containing sufficient to test one line of pipe. First, remove all casing there may be around the pipes throughout the building. Stuff tow, rags, or any convenient article, as closely as may be around the pipes where they pass from one storey to another, to prevent the smell from following the pipe upward. If possible station a person on every floor, furnished with chalk or red pencil, to mark the actual location of any detected smell. If the main drain (soil-pipe) extends through the roof, station the operator at that point, with vial and two pails of hot water. Everybody being in position, let the operator pour down the peppermint, and, as soon after as possible, both pails of water, taking care not to spill peppermint on his clothes or on the floor or roof. The observers on every floor should now try to detect any smell they may be able to, and mark any such places with chalk, so that they can be examined in detail at leisure. This is the entire operation. The person on the roof must on no account for at least ten minutes leave his position; for he will surely bring the smell with him to a greater or lesser extent, and leaks may not all be detected in less than that time. If the soil-pipe does not extend to the roof as it should, run the peppermint through the upper water-closet or set bowl. If there be more than one set of pipes, and the first is found leaky, they must be tested on different days, one at a time, as it is impossible to get all the smell out of a house in less time. The cost of the peppermint is two dollars per dozen vials. Length of time required to thoroughly inspect a building, from one to five hours, depending on the complexity of the pipe arrangement."

It is stated that this plan has been adopted for testing the drainage of some of the health resorts in the United States; and, in one instance, it was found that the smell of peppermint was imparted to the water drunk by the guests.

THE SIMLA EXHIBITION.

The Thirteenth Annual Exhibition of the Simla Fine Arts Society was opened by the Viceroy, the Marquis of Ripon, on the 17th of September. For the second time, an exhibition of native and industrial art manufactures was added to the Exhibition of the Fine Arts Society. In his remarks on declaring the Exhibition open, his Excellency said that nothing was easier than to destroy, and of all things art could, perhaps, be most easily destroyed. One form of destruction in Europe was sometimes known under the name of restoration. He hoped the day was not far distant when the ancient monuments of India might be placed under such control as would tend to preserve them intact and unmutilated to future ages. There was, much in the conditions of modern life which tended somewhat to separate and keep apart the European and native in this country, somewhat more than was the case in former days. The rapidity of communication, the weekly mails, the frequent furloughs, in spite of their advantages and blessings, all tend to a certain extent in that direction, and it is, therefore, a great satisfaction to feel that there are other circumstances connected with our time which may counteract the evil, and among them we might count that greater acquaintance we have in the present day with the history, the art, the jurisprudence of the past, which ought to help us to know better, and to appreciate more highly the native civilisation of India, to feel how ignorant is the inclination to disparage it, and that it is upon the ancient foundation of that civilisation alone that we can hope to erect, firm and enduring, the superstructure of that wider and higher life which it should be the great aim of our Government to foster and advance.

THE NATIONAL TRAINING SCHOOL FOR MUSIC.

The third Report of the Society's Committee on the National Cultivation of Music, deals with the charter for the proposed Royal College of Music so far as national cultivation of music is concerned. An article on this subject appeared in the *Times* on November 4th, which treats of the necessity for a better musical organisation in the country, and recounts the difficulties of obtaining it. The *Times* concludes as follows:—

"The practical management of the Royal College will be essentially in the hands of a Council, consisting of the president, the principal and the vice-principal, and 30 ordinary members, a considerable portion of whom, it may be assumed, will be amateurs. In this arrangement, again, a dangerous concession to our inherent hatred of centralisation may be recognised. Without wishing in the least to underrate the services of members of the Royal Family and other distinguished persons whose names will be of the greatest use in a social sense, we may point out that not much serious business can be expected from a large and miscellaneous body of gentlemen, who will meet, perhaps, two or three times in each term, and can scarcely be expected to be acquainted with the working of the institution in detail. The real power must, in the natural course of events, lie with a few professional members, who will, at the same time, be screened from all responsibility by their colleagues. Whether it is safe to place such trust even in the most trustworthy persons is a matter we need not here discuss. Certain it is that if the House of Commons is to be asked for money, it will want the responsibility of a more tangible being than an ornamental Council."

This agrees with the observations of the Musical Committee. The successful working of the Art system, instanced by numerous witnesses as worthy of imitation, is considered to show the nature of the executive management which is required for success.

RIVER FLOODS.

The following letter from Mr. C. N. Cresswell, appeared in the *Times*, of the 16th inst:—

"Permit me, as one of the Executive Committee of the last Public Health Conference at the Society of Arts, held on the 10th of June, to remind you that the subjoined resolution in reference to 'the prevention of floods' was unanimously passed at that Conference by representative men from all parts of the kingdom:—

"'This Conference is further of opinion that such re-

presentative County Boards should be instituted with the least possible delay, and that the functions intrusted to them, and the powers conferred upon them, should be wide and full, and conceived in the view of enlarging, elevating, and re-invigorating the principle of local self-government in this country; and, further, it is the opinion of this Conference that such County Boards, or combinations of them, in preference to newly-constituted authorities, should be charged with the conservancy of rivers, including the prevention of floods, the storage of water, and the preservation of rivers from pollution; and, lastly, that such County Boards should also be charged with the appointment of county health superintendents in each county.'

"This resolution, if carried into effect by Parliament, offers a solution of the formidable difficulties submitted to the consideration of Mr. Dodson on Thursday last, by the Duke of Bedford and others. Moreover, it seems to be forgotten that floods no longer leave a rich deposit of clay and other detritus upon our pastures, but, in too many cases, a filthy slime, infected with the poisonous refuse of towns and manufactories along the course of our rivers. In the opinion of some practical farmers, this is one of the causes of the abnormal diseases now prevailing among our flocks and herds, more especially among store cattle. In this aspect the question becomes one of tremendous importance, as affecting the agricultural interests, and deserves the immediate attention of Parliament."

CORRESPONDENCE.

PATENT LAW.

I have the pleasure to forward herewith a copy I have received for the Society of Arts, of the volume recording the proceedings of the "Congrès de la Propriété Industrielle," held at Paris in September, 1878, and which was attended by delegates from the Governments of Germany, Spain, the United States of America, Hungary, Italy, Luxembourg, Norway, Russia, Sweden, and Switzerland.

It may be convenient that I should take this opportunity of making a few observations as to resolutions arrived at by the Congress, some of which agree more or less with certain of the resolutions I had the honour of submitting, at the request of the Council of the Society.

The subjects enumerated in the programme included patents for inventions, industrial designs, trade marks, &c. The action taken in relation to each subject is so fully recorded in the accompanying volume, that it will no doubt be deemed sufficient if I confine my remarks to the particular branch to which the Society's resolutions had reference, viz., patents for inventions.

It will be recollected that Bills for the consolidation with amendments of the Patent-laws of the United Kingdom were introduced in the House of Lords by the late Lord Chancellor in 1875 and 1876, and in the House of Commons by the late Attorney-General in 1877.

Special meetings to consider the Bill of 1877 were held by the Society of Arts on the 6th and 9th of March in that year, when certain resolutions were passed, which will be found in the Society's *Journal* of March 16th, 1877. These were the resolutions the Council of the Society submitted to the Paris Congress. One of them (the second) had reference to the preliminary examinations of applications for letters patent, and was as follows, viz., "That no adverse report of an examiner, even with a right of appeal, ought to preclude an applicant from obtaining a patent at his own cost and risk. And further, that reports containing opinions of Patent-office authorities ought not to be made public, but that opportunity should be given to the applicant of amending his specification, by inserting reference to matters discovered by the authorities, with a definite statement of what he nevertheless claims."

The subject of preliminary examination gave rise to a long and animated discussion, and was dealt with from various points of view. The advocates of such an examination pointed out the large number of supposed inventions for which patents were taken out, and which, while only delusive, and injurious to the patentees, were, they urged, often incumbrances in the path of subsequent inventors. They argued that a previous examination by capable experts would frequently prevent these patents from being granted at all. Accordingly, our own Parliamentary Committee of 1872, the Vienna Congress in 1873, and the German Reichstag in its law of 1877, had all decided in favour of an examination. On the other hand, it was forcibly urged that the power of rejecting untried inventions for supposed want of novelty, impractibility, triviality, or any similar reason, would be a most dangerous weapon to put into the hands of examiners, however honest and capable; and instances were cited of inventions which were condemned by the highest authorities, on one or other of these grounds, and which yet proved to be most valuable. The French Patent-law, like our own, does not provide for any such examination, and it seemed possible that there would be a majority of French members against a minority containing most of the foreign delegates. However, an almost unanimous vote was at last taken in favour of a proposal based on the Society of Arts' resolution already referred to, and designed to meet both sets of advocates. The resolution, as passed, may be freely translated thus:—"Patents of invention should be granted to any applicant at his own risk'; nevertheless, it is desirable that the applicant should receive a previous secret opinion, notably on the question of novelty, so that he may, at his option, maintain, modify, or abandon his claim."

As bearing upon compulsory licenses, the following free translation of a resolution of the Congress may be given:—"A patent should, during the whole of its term, assure to the inventor or his representatives the exclusive right to work the invention, and not a mere right to a royalty to be paid him by third parties working the invention."

As respects compulsory working, the Congress adopted a resolution to the effect that "it is desirable to admit of forfeiture for default of working within a term to be determined, unless the patentee justify the causes of his inaction." I may perhaps say, speaking from experience, that this resolution strikes me as most objectionable.

The Congress expressed the opinion that "a special office of industrial property should be established in each country. A central depôt of patents of invention, trade marks, and industrial designs should be annexed for the purpose of communication to the public. Independently of any other publications, the office of industrial property should cause an official sheet to be issued periodically."

As respects fees, the resolutions of the Congress may be stated thus, viz. (1) that the tax on patents should be periodical and annual; (2) that it should be progressive, commencing with a moderate initial sum; (3) that it should only be demandable in the course of the year; (4) that forfeiture by reason of default in the payment of the tax should not be pronounced, except after the expiration of a certain delay after it becomes due; (5) that even after the expiration of this delay, it should be open to the patentee to justify the reasons of his having been prevented from paying; and (6) that this forfeiture should be pronounced by the ordinary tribunals, and not by the administration.

One of the most important resolutions passed was to the effect "that the rights acquired by patents or the registration of designs and trade marks in different countries, should be independent of each other, and in no respect interdependent, as is now the case in many countries."

It would be almost impossible to exaggerate the importance of this point, especially seeing that the country heretofore regarded as possessing the most liberal Patent-law, viz., the United States of America, seems now to be straining the interdependent theory to the very utmost extent, thereby seriously hampering patentees, without, so far as I can see, any adequate gain to the public. I think it will be found the resolutions above enumerated are those which deal most nearly with the points analagous to those to which the Society of Arts' resolutions already mentioned had reference.

Before separating, the Congress appointed a permanent committee to continue the work it commenced. This committee is composed of sections, one for each of the countries represented, the French section being the executive committee. The English section consists of Admiral Selwyn (chairman), Sir W. Thomson, F.R.S., Sir Henry Bessemer, F.R.S., Mr. Gorst, Q.C., M.P., Mr. J. G. Alexander, LL.B. (hon sec.), and myself. Unfortunately, the committee recently lost a very active member in Mr. Olrick, C.E., who died in August last.

Since the Congress, the permanent committee have occupied themselves in forwarding the carrying out by the Governments of Europe of the resolutions of the Congress, and with this object the French section of the committee entered into communication with their own Government. The French Government having expressed its willingness to take the initiative in bringing about some measure of international concert, the French section prepared, and laid before it, a proposal containing those resolutions of the Congress which seemed capable of immediate realisation for an international convention for the protection of patents, trade marks, and designs; and this proposal was sent round to the different Governments by that of France, together with an invitation to concur in an international conference for the purpose of settling such a convention. Several Governments have expressed their willingness to take part in such a conference, and I understand it will shortly be held.

At the same time, the French section of the committee, desiring to complete the work of the Congress with regard to those questions which it had been unable to enter into, prepared and sent round to the different national sections *questionnaires* to elicit their opinions on these points. Two such *questionnaires*, one on patents, and the other on designs, have been sent round, and answers have been supplied by, at any rate, the greater part of the sections.

W. LLOYD WISE.

7, Whitehall-place, London, S.W.,
October 30th, 1880.

GENERAL NOTES.

Fleuss's Diving Apparatus.—Messrs. Fleuss and Duff have called attention, in a letter to the editor of the *Times*, to the successful use of Fleuss's Patent Diving Apparatus, in that part of the Severn tunnel which is now inundated:—"The diver has succeeded in getting down the shaft, some 200 ft. deep, and then going a quarter of a mile up to the head of the tunnel, in order to close up the door so that the pumps might be enabled to clear the water out. After several unsuccessful attempts with the ordinary gear, we were applied to for our apparatus, and this was tried on Thursday, and proved a complete success, the diver easily accomplishing what had become an impossibility with the ordinary means of diving, owing to the great length of air tube necessarily required."

The Electric Light.—Satisfactory progress is being made in London and Paris with the Jamin system of electric lighting. Mr. Bell, the representative of the company here, is employed in fitting up an extensive plant at the establishment of Messrs. Samuel Brothers, to replace the Jablochkoff lights in use there last year. The machines will be driven by a 12-horse power silent Otto gas engine, which will actuate two self-exciting Gramme machines working from four to sixteen Jamin lights each, and which will be employed to feed twenty lamps, unless the power available should be sufficient for the whole thirty-two lamps. The speed of the Gramme machines will be 1,600 revolutions per minute. During some recent experiments in Paris, a pair of Gramme machines, exciter and distributor separate, and of the type formerly known as four-light machines, were able to maintain, when driven at a speed of 2,500 revolutions per minute, sixteen Jamin lights. The machines had been slightly altered by M. Jamin, and can be driven at 3,000 revolutions per minute without appreciably heating the coil. The Royal Panorama building now being completed in Leicester-square is to be lighted with thirty Jamin lights.—*Engineering.*

MEETINGS FOR THE ENSUING WEEK.

MONDAY, Nov. 22ND...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. A. H. Church, "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." (Lecture I.)

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. Francis Turner, "The Law as affecting Quantity-Surveyors."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Right Hon. Sir H. Bartle E. Frere, "Temperate South Africa considered as a Route to the Central Equatorial Region."

Medical, 11, Chandos-street, W., 8½ p.m.

TUESDAY, Nov. 23RD...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. J. P. Maxwell, "New Zealand Government Railways." 2. Mr. J. R. Mosse, "Ceylon Government Railways."

Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m.

Royal Colonial, the Grosvenor Gallery Library, 135, New Bond-street, W., 8 p.m. Mr. T. B. H. Berkeley, "The Leeward Islands."

WEDNESDAY, Nov. 24TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. J. Comyns Carr, "The Influence of Barry upon English Art."

Telegraph Engineers, 25, Great George-street, S.W., 8 p.m. Mr. J. W. Swan, "A System of Subdividing the Electric Light."

Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. F. G. Fleay, "The Living Key to English Spelling Reform now found in History and Etymology."

THURSDAY, Nov. 25TH...Royal, Burlington-house, W., 8½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

FRIDAY, Nov. 26TH...Quekett Microscopical Club, University College, W.C., 8 p.m.

Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, Nov. 27TH...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Dr. J. H. Gladstone, "Refraction Equivalent." 2. Lieut. L. Darwin, "The Rate of Loss of Light from Phosphorescent Surfaces." 3. Mr. D. H. Coffin, "Minor Applications of Electro-Motors."

Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

PRACTICAL EXAMINATIONS IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination at the Society's house will be held during the week commencing January 10th, 1881. Particulars will be forwarded on application to the Secretary, Society of Arts, John-street, Adelphi. No names can be received after the 24th December, 1880.

THE VICTOR

From the Picture by JAMES BARRY, R.

OF OLYMPIA

the Great Room of the Society of Arts

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,462. Vol. XXIX.

FRIDAY, NOVEMBER 26, 1880.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

THE PHOTOPHONE.

Since the announcement in the last number of the *Journal*, Professor Graham Bell, who happens to be, for a short time, in England, has agreed to read a paper on his "Photophone" before the Society, on Wednesday, 1st December, in place of Mr. W. H. Preece, who is unable to read his paper on that day. Mr. F. J. Bramwell, F.R.S., Chairman of the Council, will preside. For the convenience of those members who wish to be present, the usual rules for the admission of members and their friends will be suspended. Admission will be by ticket only, and no person, whether a member or not, can be admitted without a ticket. A sufficient number of tickets to fill the room will be issued to applicants, in the order in which they apply. Each ticket will admit one person, and is transferable. Not more than a single ticket can be issued to any one member. Some tickets have already been issued, but it is hoped that all members who apply in good time may be accommodated; they should, however, apply at once to the Secretary. By order,

H. Trueman Wood, *Secretary.*

UNION OF INSTITUTIONS.

The following Institution has been received into the Union since the last announcement :—

Gloucester-house School Science and Art Classes, Dodington, near Sittingbourne.

FOREIGN AND COLONIAL SECTION.

A meeting of Committee of this Section was held on Thursday, 19th inst., at 4 p.m. Present: —Sir Rutherford Alcock, K.C.B. (in the chair), Mr. Andrew Cassels, Mr. Hyde Clarke, Mr. C. Pfoundes, Mr. Trelawney Saunders, Mr. J. A. Youl, with Mr. H. Trueman Wood, secretary, and Dr. R. J. Mann, secretary of the Section. The programme of papers to be read during the present Session was discussed and agreed upon.

CANTOR LECTURES.

The first lecture of the first course was delivered on Monday, 22nd inst., by Prof. A. H. Church, M.A., F.R.S., on "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." The lecturer dealt with bricks, tiles, terra-cotta, basaltes, and unglazed earthenware in general. The lectures will be printed in the *Journal* during the Christmas recess.

BARRY'S "VICTORS OF OLYMPIA."

With the present number of the *Journal* is issued, as a supplement, an engraving of Barry's picture of the "Victors of Olympia." The engraving is intended to illustrate Mr. Comyns Carr's paper on Barry, and is reproduced from the woodcut published by the Art Union in a series of "Thirty Pictures by Deceased British Artists, engraved by W. J. Linton." The block has been kindly lent for this purpose by the Council of the Art Union. A small number have been printed on better paper, and any member who wishes for a copy to bind with the *Journal* can have one, gratis, on application, or a copy will be posted on receipt of one shilling.

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PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

Wednesday, November 24th, 1880; Sir Henry Cole, K.C.B., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Brenchley, Samuel, Hunt Bridge-house, Matlock.
Gassiot, Charles, Elmwood-house, Upper Tooting.
Gundry, Joseph Pearkes, the Cottage, Bridport, Dorsetshire.
Jaques, Leonard, J.P., Wentbridge-house, Pontefract, Yorkshire.
Laxton, Frederick, Brighouse, Yorkshire.
Nix, John H., 77, Lombard-street, E.C.
Noel, Hon. Henry, 17, Westbourne-terrace, W.
Northampton, Marquis of, Castle Ashby, Northampton.
Ormerod, Thomas, Woodfield, Brighouse, Yorkshire.
Robertson. Sir D. Brooke, C.B., Athenæum Club, S.W.
Robertson, J. Murray, Lower Grove-house, Roehampton.
Seymour, Major-General W. H., Travellers' Club, Pall-mall, S.W.
Sheppard, Samuel Gurney, 31, Oxford-square, W.
Simmons, Charles J., 56, Leverton-street, Leighton-road, N.W.
Skaife, John Slade, 32, Milner-square, N.
Slade, Francis William, Eldon-pk., South Norwood, S.E.
Volk, Magnus, 40, Preston-road, Brighton.

The paper read was—

THE INFLUENCE OF BARRY UPON ENGLISH ART.

By J. Comyns Carr.

In the summer of the year 1788, a young Irish artist arrived in London, bearing a letter of introduction to James Barry. At that time Barry had accomplished the great work of his life. The pictures which hang round the walls of this room, and which are justly reckoned as the highest effort of his genius, had been completed in 1783. In the previous year he had been appointed professor of painting in the Royal Academy, and his exercise of the functions of this office had not yet led to the series of unhappy and unfortunate disputes which terminated at last in his expulsion. Barry may, therefore, be said to have been in the full enjoyment of his fame. The youth who came to seek his friendship was, on the contrary, only just entering upon his career. Martin Archer Shee was destined to rise to the highest dignity in his profession. Forty years later he became president of the Royal Academy; and the courtly manner in which he discharged the duties of his position tend, perhaps, as much as his purely artistic gifts, to the permanence of his fame. We may assume that he already possessed some of those essential qualifications for success which Barry had always lacked. Indeed, his biographer assures us that even at this early age the young man's manners were regulated by "the highest standard of social propriety which the circles of Dublin afforded," and that such was his punctilious exactness in matters pertaining to the toilette, that, in common with most of the men of fashion of his time, he passed an hour every day under the care of his hairdresser. It is impossible to conceive of a more striking contrast than is presented between this elegant youth and the morose and solitary artist; and it is easy to imagine the shock which such a polished young gentleman must have experienced on his first introduction to Barry in his poor and lonely lodging. Writing home to his brother immediately after his visit, Shee preserves for us this lively picture of the artist and his surroundings. "Conceive," he says, "a little ordinary man, not in the most graceful dishabille, a dirty shirt without any cravat, his neck open, and a tolerable length of beard, his stockings, not of the purest white in the world, hanging about his heels, sitting at a small table in the midst of this artificial confusion, etching a plate from one of his own designs." And of the apartment itself he continues in the same strain. "The floor," he tells us, "seemed never to have experienced the luxury of an application of soap and water. The centre of it was covered by a carpet, the colour of which might once have been discoverable, but, from its intimate connection with dust and dirty feet, had long since ceased to be distinguishable from the more exposed part of the flooring." "The walls," he adds, "were perfectly concealed by an innumerable quantity of little statues, busts, and old pictures, besides casts of legs, arms, skulls, bones, hands, feet, sketches, prints, drawings, palettes, pencils, colours, canvases, frames, and every other implement calculated for the use of art, disposed in all the confusion and disorder of the most negligent carelessness."

There is something eminently suggestive in the meeting of these two men: the one young and confident, gifted with the social qualities that ensured the sympathy of the world, and attached to a branch of art which at that time offered the only safe road to wealth and fame; the other, not yet old in years, it is true, but already arrived at the limit of his hope and ambition, cursed with a nature that had left him almost without friends and wholly without patrons, disappointed in the pursuit of a kind of art that was strange to the temper of his time, yet still resolute in the labour he had undertaken, and steadfast to the last in the faith with which he had entered upon his career. Twenty years had passed since Barry himself had come, like Shee, to try his fortunes in London, and now, although he had still many years to live, his career was practically ended. In spite of the bright hopes of the lad himself, and of the friends who had recognised and encouraged his earlier efforts, that career had been a failure. I have said he was just then in the full enjoyment of his fame, but, in truth, he never really won the sympathy of his generation, and his fame brought with it but small earthly reward. In this very year he was pleading with the Duke of Richmond for a place in the Ordnance Department, in order that he might find ease and time to produce something worthy of the eighteenth century. He was straitened in circumstances, and embittered by the sense of his isolation, and the imperfect recognition of his fellows. But this was not all. If Barry had only missed the appreciation of his time, it would be indeed a pleasant task for us of a later day to review the hardships of his life, to mark the noble aim which he ever kept before him, to recall his extraordinary resolution and self-denial, and to welcome as our inheritance the great results he achieved. Unhappily, however, Barry's failure was within as well as without. The embittered circumstances of his life have for us an extra note of pain, for the reason that we cannot rate at the value he set upon them the works that he spent his strength in producing. We cannot but perceive, looking back after this lapse of time, that between the grandeur of his conceptions, and the shapes in which they were expressed, there is a gap such as he did not dream of. I do not mean to deny the admirable qualities of Barry's work, I am well aware of the difficulties under which he laboured, and I am anxious to recognise, at its full value, the extraordinary courage with which he imagined and carried to completion the most extended experiment in decorative design which has yet been produced in this country. That, without any national tradition to guide him, and without the encouragement of contemporary examples, he should have executed the vast canvases that surround us to-night, proves, I think, that Barry possessed real power as well as a noble ambition. And yet, when all has been said that justice demands, there must still remain, I think, a painful conviction of Barry's failure. We may admit that he was not rightly understood by his age, but we must also acknowledge that he did not truly understand the kind of beauty in art which he desired to express. Of the dead, we are told, we should say nothing which is not good. It is a poor saying, for the dead of all men most sternly reject insincerity of praise, and it is no injustice to Barry's memory, to distinguish truly the inherent limitation of his powers. Rather it may be said, that the sense of

his failure gives a peculiar pathos to the record of his career. It is impossible not to be touched by the picture of this man, who, from boyhood, had denied himself all luxury and relaxation; who lived upon the most frugal fare, and amid the simplest surroundings, in order that he might the better carry out the great and noble designs which he entertained for the advancement of our English school. And our sympathies with his labour and with his fate are only quickened by the thought that, to some extent, he laboured in vain; for the failure of which we have spoken was, in a measure, independent of individual will or power. If we consider carefully Barry's position in the history of our school, we shall see that, although his want of success was partly due to the temper of the man and the quality of his genius, yet that it was, in a deeper and truer sense, to be ascribed to the temper of his time, and to the general conditions under which painting had been practised in Europe. Other men might have won greater applause and a larger share of popular homage. No man, whatever his disposition, could have hoped, at that time, for absolute success in the realm of art which Barry sought to inhabit; and it therefore becomes a question of peculiar interest to consider what there was in the spirit of the age, and in the general condition of the art, to shut out the members of our English school from the highest triumphs of imaginative design.

For the causes of that strange isolation in which he passed his life, we must indeed look to the facts of his character. Barry, even in his boyhood, showed an inclination to separate himself from his fellows. Born at Cork, in the year 1741, he was at first destined for his father's business of a coasting trader; but he quickly discovered a talent for design, and while he was still at school, he entered upon an independent course of study, and rarely mixed in the ordinary boyish games or amusements. While others were at play, he would steal off to his room and set to work with his pencil, or busy himself in the reading of some book that he had borrowed or bought. He used to alarm his mother by sitting up all night at his work, and when they strove to force him to rest, he would lock his door, and allow no one to enter his room, not even for the purpose of making up his bed. When he was scarcely twenty, he began a picture of St. Patrick landing on the coast of Cashel, and with this first trial of his strength he journeyed to Dublin, where he arrived just in time to have the work displayed in the exhibition of the Society. Here it attracted the notice of Mr. Burke, and thus there began, between the statesman and the painter, a friendship that endured for many years, and the records of which offer almost the only means we possess of following the after course of Barry's career. There is something wholly delightful in the earlier relations of these two men, and it is almost pitiful to note, in later years, how Burke's protecting kindness and wise anxiety for the painter's future, grew, by degrees, more reticent in expression, as the fiercer elements of Barry's character developed, and his wayward independence of temperament began to assert itself. With Burke's family Barry crossed to England, and mainly through Burke's generosity, he was enabled soon after to set out for Rome. But a little before, he seems to have almost despaired of ever reaching this long desired goal. "I am still," he writes to a friend in Cork, "at work for Mr. Stewart, and not likely to think of anything else, God knows how long, having weaned myself as much as possible from the thought of going to Italy, which has already been attended with too much disappointment and vexation." Barry's letters, describing the experiences of his journey to Rome, are full of the most sincere expressions of gratitude for his patron's kindness, and the tone of Burke's replies proves that he too entertained a real affection for the young painter. "I love you, and I esteem you," he writes, "and I wish your welfare and your credit as much as any man." To preserve during all the years of their intercourse this kindliness of feeling, must often have been to Burke a matter of difficulty and trial. Not that Barry was at any time indifferent to the value of the friendship that subsisted between them, or disposed to underrate the great benefits which it had conferred upon him. But he could not, at all times, govern his temper; he was apt to let slight and trivial disagreements obscure the memory of a noble friendship, so that there came at last a time when Burke, instead of beginning his letters with the familiar words, "My dear Barry," came at last to adopt the chilling form of "presenting his compliments" to the solitary artist. But in these earlier days Burke shows no sign of sensitiveness in his own person; all his anxiety is for Barry's future, and for the evil that he will bring upon himself, unless he can learn to bear with his fellow-men, and to keep his mind in tranquility for his work. Barry had already made himself unpopular with the artists in Rome, by seeking, with too much candour, to expose the tricks and frauds of the dealers in antiquity that haunted the city. Reynolds, who took a genuine interest in the young Irishman's career, is called in to give advice. Burke adds some of his own to the same effect. The wrathful and irascible student is warned by both against being led away from his own concerns by the malice and envy of others. He is advised to let these pretty tricksters go their own way instead of quarrelling with them. "There is," says Burke, "no living in the world upon any other terms." These small incidents in Barry's sojourn at Rome would be scarcely worth quoting, save for the indication they afford us of the morbid element in his character. In a letter written during the latter part of his stay abroad, we get the first hint of that deep strain of melancholy and mistrust, which was so strangely combined with his arrogance and irritability. Speaking of his approaching return, he writes in a desponding fashion of the taste of his countrymen. "Oh, I could be happy," he cries, "on my going home to find some corner where I could sit down in the middle of my studies, books, and casts after the antique, to paint this work and others; where I might have models of nature when necessary, bread and soup, and a coat to cover me. I should care not what became of my work when it was done, but I reflect with horror upon such a fellow as I am, and with such a kind of art in London, with house rent to pay, duns to follow me, and employers to look for." It is not to be thought that such an utterance as this was only the feeble expression of youthful

enthusiasm. His whole life proved that Barry was ready and willing to make any sacrifice for his art; and there is in all the history of art no more notable instance of absolute devotion to an ideal, a devotion which, in regard to material concerns, made no claim upon the indulgence or forbearance of others. Those who came in contact with Barry, had assuredly much to bear from his perverse and ungovernable disposition; but it is at least a noble trait in his character, that he duly counted the cost of each adventure he was to make, that he did not seek to shift his burdens on to other shoulders, and that the full extent of his failure fell chiefly in hardships inflicted upon himself. At the time that he undertook the decoration of this great room he had, so his biographer tells us, but sixteen shillings in his pocket; and during the execution of these vast canvases, he was constantly compelled, after his day's work was done, to employ himself in the evenings on drawings and etchings for the publishers. Barry's arrangement with the Society, as you are doubtless aware, through the interesting account of these transactions lately issued by your Secretary, was that he should paint these pictures at his own risk, the Society only undertaking to provide the materials, and to hand over to him the receipts arising from their public exhibition. Barry never flinched from the labour; but he must, at times, have looked forward with something like dismay to his means of livelihood during the progress of the work. In such a mood it must have been that he penned a letter to Sir George Saville, one of the vice-presidents of the Society, asking that gentleman to head a subscription in order to give the painter command of a hundred pounds a year. There is no record of any practical issue to his appeal, but to me, I confess, there is a simple dignity in this letter, which aptly accords with the proved integrity of the man. "My request and wish," he says, "is that you, sir, would subscribe £20 or £10 yourself, and prevail with such of the Society as you think proper to subscribe also, to make in the whole the annual sum of £100, to be given me monthly or quarterly, as the work goes on. I shall, by that means, be enabled to give myself up entirely to it until it be finished, which, with God's blessing, will be in about two years; and then the sum of £200, which I shall have received, shall be paid back to you and to those other public-spirited gentleman who lent it to me. If the exhibition produces nothing, or that the Society should neglect to make one, you will then lose your money; but a public work will be completed, and I shall be happy; as the opportunity of throwing myself out in such a work will be, to me, a reward fully sufficient."

This frank appeal seems to me wholly worthy of the man, and of the generous spirit in which he had undertaken this great work for the Society. That he was partly impelled by personal ambition is, no doubt, true enough. What artist is there who does not feel and acknowledge the desire of fame? But he was quite as powerfully urged to the undertaking by a truly noble desire to establish in the English school a tradition of monumental design. He had been disgusted and enraged by the failure in the previous year of the scheme for the decoration of St. Paul's; and when Reynolds and the other members of the Academy declined the invitation of the Society to decorate this room, he came forward with alacrity and took the labour altogether upon himself. It would be easy to multiply instances bearing witness to the finer side of Barry's character; but, alas! it was not always easy for those who were his contemporaries to do justice to the grandeur of his ideas. His most generous schemes, devised for the advancement of English art, were so complicated by the violence of his temper, and by an ungenerous mistrust and suspicion of his fellows, that we are not to be surprised if he sometimes, during his career, received less than his due share of praise. His quarrel with the Academy brings prominently before us both the best and worst sides of the man's nature. The employment of the professorial chair for personal attacks upon his brother Academicians must have been intolerable to them, and I can understand that they should justly decide to deprive him of his office; but I do not understand, nor do I think any just mind can now defend, the course which they took in expelling him from the society. I cannot forget, for my own part, that Barry was not merely an intemperate lecturer, but that he was, at the same time, an enlightened and persistent advocate of reform. He incurred the displeasure of the Royal Academy, not only for his personal arrogance, but because he urged upon that body such a large and liberal conception of their duty towards the public, as did then, and has ever since, met with stubborn and dogged resistance from the majority of its members. The present is not the fit time to enter upon a question of this magnitude, but so much, at least, may be said, that if the Royal Academy had followed the lines of policy which Barry laid down, it would now be occupying a very different and a more dignified place in the esteem of the nation, and of the general body of artists. We cannot conceive of such an institution as Barry contemplated ever claiming, as the Academy once claimed, to be a private society independent of national control.

When we turn from Barry's character to Barry's art, we get upon less disputable ground. I shall not attempt to-night, with any fullness of detail, either to expound the merits or to mark the defects of Barry's painting. His most important work hangs before your eyes, and I scarcely think it likely that there is in our time room for much dispute as to the intrinsic value of the result. Whatever praise may now be accorded to his talent, would go but a little way towards satisfying the claims that were at one time put forward on his behalf. His indulgent biographer contrasts his genius with that of Raphael, not altogether to Raphael's advantage; and Barry himself, I think, believed that he had established a style combining the noblest qualities of the antique with the chosen excellence of the greatest of the Italians. Looking back with that cruel clearness of vision which comes with lapse of time, we can perceive the absolute insecurity of these pretensions. We are able to recognise that such art as this, could not, in its nature, be a full or satisfying expression of the mind of its epoch. The failure, as we have already observed, was in this sense not Barry's alone; as he was among the first, so also he was in the same respect the

greatest of those who laboured in vain. But the classical sentiment which dominated his style, and which pervaded all the art of the eighteenth century, which strove for the embodiment of imaginative ideas, was in two ways absolutely fatal to the production of any work of real and full vitality. For in the first place, be it remembered, that the conception of the antique world which then governed men's minds was in its essence a dead and paralysing conception. The formula which pedantic criticism and the fashion of the time had combined to force upon the world was such as by no ingenuity could be made to express the movement, the passion, and the variety of human life. Men who swore obedience to such a straitened ideal were compelled, even against their will, to falter in their devotion to nature, and to rigidly exclude from their sympathies the feelings and sentiments of their age. Even a genius so true and so refined as Flaxman's could not wholly escape from the mark of this fashion. He was so far restrained by the prevailing spirit, that he could only reconstruct the classic ideal within the limits of a domestic existence. So often as he ventured into a wide realm, so often do his works bear the impress of reverent learning rather than of individual power. He could not express, through classic forms, the presence of the modern spirit; he had not the strength which could forge the link to bind the old with the new, and if we compare his transcript of Greek art with that which had been made by the masters of the Renaissance, we shall have to confess that, although it bears externally the marks of a greater fidelity to the past, it has not an equal sympathy to attach itself to the realities of a present world.

If we can recognise this limitation in the noblest sculpture of the time, how much more strongly must it impress itself upon the products of an art whose resources imperatively demand vividness of realisation, and whose effects are therefore forced into closer comparison with the facts of nature. Painting, of all the many forms of artistic expressions, can the least afford to accept a convention which seeks to exclude from its views the energy and passion of actual life; and, in yielding to such an influence, it must inevitably take refuge in the nerveless grandeur of Barry's colossal style, or sink into the pretty insipidities of a Cipriani or a Kauffman. But this devotion to a false and limited idea of antique grace was not merely a source of weakness in itself; it served no less to deprive the painters of the eighteenth century of the full benefit they might have derived from the teaching and example of the great masters of the past. Few artists of his age could boast of a wider and more generous appreciation of Italian art than was possessed by Barry. His letters from Rome, and his notes upon the paintings and sculpture in Venice and Florence, prove that he understood, with a justice and discrimination that were rare in his day, the several stages in the advancement of the art, from Giotto to Michael Angelo. He never assuredly made a better use of his fiery and impetuous temper than when he boldly lectured the monks at Milan upon their folly in painting the "Last Supper" of Leonardo; and the energy of his discourse on that occasion would, I think, almost suffice to strike terror into the heart of a modern restorer. But, in spite of Barry's real enthusiasm for the painters of the Renaissance, it is easy to perceive that he was constantly testing their work by reference to the standard of the antique. He did not study or accept them, in the sense in which they have since been studied and accepted, as the instruments of a great imaginative impulse, whose individuality was stamped not less upon the method than upon the essence of their art; he chose rather to measure his praise of their genius according as he found they approached in their work to the correctness and proportion of ancient sculpture. Such a process of investigation could not be expected to reach the real spirit of Italian art. It was conducted by men who were intellectually already pledged to an impoverished ideal, which a pedantic criticism had chosen to graft upon antiquity, and who, therefore, discovered that Raphael and Michael Angelo had little to teach, which could not be better acquired from the surviving records of the art of Greece and Rome. There was, indeed, one man in England, who possessed a keener insight into the great imaginative design of Florence, and better understood the uses of its example. The genius of Blake shot a momentary radiance across the dull sky, which others could not penetrate at all, and then sank downward, with no sure footing to tread the earth. He had the vision which showed him how great a thing painting had been when it stood as the mirror of men's highest imaginings, and he was quick to perceive the extent of the change that was needed before English painting could hope to undertake this difficult duty. But he must be judged as a seer rather than as an artist, for he had no strength sufficient to effect the revolution he so ardently desired, and while he failed through lack of practical power, others who were, like Barry, more perfectly equipped, failed no less from the lack of that intensity of imagination which in Blake was developed to the point of disease.

The defects that might be anticipated from this superstitious devotion to classic style, with its consequent misapprehension of the greatness of Italian design, are easily traceable in the works of Barry. We are struck at once, in looking at his pictures, with the want of individuality, not merely in the features but in the forms, with the lack of passion and character in the faces, with the absence of expressive energy in the movement of the limbs. The action is either tame or exaggerated; the figures, even where the scale is colossal, are wanting in grandeur and dignity, and, at first sight, these things are more surprising, seeing that there existed at this time another kind of art which would specially tend to the development of the very qualities we miss. It is a remarkable phenomenon that the efforts of men like Barry, and West, and Haydon, were contemporary with a series of the most brilliant triumphs in the practice of portraiture; and nothing shows more conclusively the insecure basis of the so-called ideal art of the period than its rigid and determined exclusion of all those qualities which make portraiture interesting. The comparison of two men like Barry and Reynolds must now be fatal to the pretensions of the former. Nor is this dependent merely upon difference of individual genius. If Reynolds had undertaken the task that

Barry attempted, he too would have failed in a greater or less degree, and it remains for us to consider, as one of the most interesting problems connected with art history, in what manner the gradual progress of painting in England and in Europe had led to the decay of imaginative design, and to the assured supremacy of the departments of portrait, landscape, and the realistic illustration of contemporary manners. Looking first to England, we may see that the force of the Reformation, whatever may have been the gains in a spiritual sense, had unquestionably the effect of suddenly snapping the artistic tradition. It is not to be said that, even under more fortunate conditions, our early English painters could ever, by their independent effort, have enlarged the capabilities of their art as to render it fit to compete with that of other nations, but it is nevertheless true that, up to the time of the Reformation, English painting had a real existence; and if we go back to a still earlier date, we shall discover a period when the illuminated works of English MSS. were the most perfect in Europe. If, then, the Reformation, with the Puritan movement by which it was followed, had not entirely depressed the artistic spirit, the successive revolutions of style, which were deferred till the next century, might have more rapidly completed themselves, and the English school, as we now know it, would have had an earlier birth. But, when the Reformation came, the imaginative impulse was turned into a different channel. The force of the Protestant feeling expended itself in denunciation of the ornate luxury by which the earlier ritual had been surrounded, and, in the condemnation of Romish doctrine and practice, it was inevitable that all the outward graces of life, and the arts by which they were sustained, should be temporarily discouraged. Imagination, escaping from the control of the Church, and seeking for itself a freer realm, became, by a strange irony of fate, one of the strongest elements of opposition to the art which, of all others, most imperatively needs imagination; and the artist, thus deprived of the sympathies of those who led the new movement of ideas, made scarce any effort to keep pace with the intellectual development of the time. All the strength of our Renaissance found expression in our literature, and we are left to guess who, among the earlier poets of our school, might, under different conditions of national life, have become great imaginative painters. I know not if it is only a fancy, but I have sometimes thought that in the author of the "Fairy Queen" there dwelt the soul of a painter; and in the precise and ordered pattern of his verse, so richly and so lovingly adorned with the description of all that might give delight to the eye, we have enshrined a series of visions that might, under other conditions, have found their way on to fresco or canvas. But it is only in the earlier stages of our literature that we are permitted to indulge such fancies, for soon the poet became also the dramatist; and the drama, while it is the highest expression of the literary spirit, serves also most clearly to assert the distinctions between the modes of literature and art.

Seeing, then, how completely literature had absorbed the national energies, it is not surprising to find that the after growth of art in England is due to a foreign source. In the minds and in the homes of the cultivated classes, the taste for art survived, and we had great collectors and connoisseurs before we could boast of great artists. Even before the Reformation had left its mark upon the English spirit, Holbein had found a home at the English Court, and when the work of the Reformation was complete, or nearly complete, Rubens, and his great pupil, Vandyck, were invited to our shores. At first sight, indeed, it may seem strange that the residence among us of these great masters of the craft did not avail, at once, to establish the tradition of imaginative design, but the solution of this riddle is to be sought as well in the nature of the art of which these men were the professors, as in that determined impulse towards literature of which we have already taken account.

When Vandyck entered upon his career, painting, it must be remembered, was no longer fit to undertake the expression of the higher problems of the spirit. In the hands of Rubens himself, art had already reached and surpassed the utmost limits of artistic license. The force, no less than the failure, of his invention put an end for a while to all further study of imaginative design, and the fallacious splendour of his most ambitious achievement was more than enough to drive other artists of less gift, or of greater refinement, into a narrower realm. To realise the decadence in the spiritual elements of painting that had been effected by the time Rubens's career was complete, it is only necessary to refer to his own copy of Mantegna, in the National Gallery, and to compare it with the original cartoon at Hampton Court. As we stand before the brilliant essay of this matchless master of the brush, we have to confess to ourselves that one great epoch in ideal art was closed when gods and goddesses descended to take upon themselves the ample flesh of Flemish men and women. Rubens himself was passionately attracted by the noble inventions of the great masters of Italy, and, with his unapproachable talent, he, if any man, could have revived and sustained the tradition they had established. He had lovingly copied their paintings, and studied their drawings; he had passed from Venice to Florence, reaping, as he went, all the harvest that was still left upon the field; and yet, as often as he tries to emulate these earlier triumphs, so often does he assert, with all the frankness of his genius, that their empire had ended, and that art had entered upon a new career.

It is no part of our task to-night to follow the growth, or to note the decay, of the imaginative schools of Italy; and we have no right to linger over those noble aims in painting which Giotto had furnished, and to the fulfilment of which the mighty genius of Michael Angelo was finally summoned. All that we have to observe is, that painting in the hands of such a race of gifted artists as the world never before had seen, and, perhaps, never shall see again, was at last so raised in dignity and power, that the world itself and all the fortunes of humanity became reflected in the shapes of its creation. Starting with the duty of illustrating the legends of the Christian faith, these men of Florence had so deeply penetrated the secrets of nature as to be led at last to recognise, with the delight of new discovery, the charm and power of the antique; and

then, advancing with the models of the antique to guide them, and with the strength of their own impulse to save them from the pedantries of mere imitation, they were able to create a style for themselves, large enough to express all the aspirations, the fears, and the fate of humanity, and, simple enough to keep its hold to the end upon the truth and simplicity of nature. But, with the death of Michael Angelo, the bright day of Florentine art passed swiftly away into darkness, and we have to look elsewhere for the growth of those elements that still kept their vitality when they were transported into the practice of the schools of Northern Europe.

Venice, for a while, and in her earlier days, had pursued, with Florence, the study of spiritual truth, and, so long as the name of Mantegna remained as a power at Venice, the products of the school kept about them something of their primitive force. We may recognise the influence of Mantegna's genius while Titian was still in his youth and early manhood, but Titian, with a career that extended to the verge of a century, lived to witness, and partly to effect, the first changes in a revolution that was destined to colour the art-work of all succeding generations. Of a genius too great and sincere to labour in the service of an expiring tradition, and too youthful in spirit, even to the close of his long life, not to feel and to accept the new influences that were asserting themselves, Titian, in his own painting, already presents to us some of those elements that have been found so fruitful in the work of later schools. It was he (as his latest biographers have reminded us) in the catalogue of whose works there is to be found the first mention of a picture that was nothing more than a landscape. It was he, also, who first gave dignity and influence to the profession of the portrait painter; and it is by no mere accident that these two modern modes of art found such powerful expression at his hands. Their establishment, at that time, signalised the exhaustion of the material upon which the earlier and more paasionate art had employed itself, and gave warning that painting was about to make a new return to nature, to regain the freshness and the veracity it had lost, and, perhaps, one day, to bring back new resources of reality, to be moulded once more to the shape and colour of our sublimest thoughts. That day has, perhaps, not yet come. From Titian's time to our own, the claims of realism have been in the ascendant. For 300 years art has mainly rested content with the triumph of imitative skill, and nearly all that has possessed a different aim has been rather artificially grafted upon its epoch, and never freely born of the hour.

And yet, in this long communion with the realities of nature, there is to be found an element of hope for the future. For it is not to be thought that the progress of the painter's or the sculptor's craft represents one continuous and steady development. The history of the past, if we read it aright, would seem rather to show that art is for ever passing from symbol to illusion, and back again from illusion to symbolism. The artist, in his relation to the outward realities of the world, is like a settler in some new and untilled tract of country, who begins by making a clearing for his home, and gradually transforms what he has won, until it bears, in every corner, the impress of his spirit and the mode of his daily life. And then, when cultivation has done its appointed task, when flowers have grown up in barren places, and patterns of his own devising have been spread over the surface of the land, the adventurous spirit, which had first led him so far from the common ways of men, once more reasserts itself. He begins to weary of the work of his hand, and grows fatigued with the order and regularity which he has so carefully implanted upon the chaos he had found. He sighs for the wilder growths that lies beyond his present domain, until, with quickened energy, and a sense almost of disgust for what he has achieved, he passes once more into the outer tangle of untamed reality, and loses himself, for a while, in the rich luxuriance of a primitive world.

And so it is with the life of art. The glory of art lies in its power to transform the common facts of nature, till they take a colour and passion from the human spirit; but, in this glory, lurk the elements of decay; for what was the living symbol in the minds of one age, becomes in the next a thing of out-worn fashion and uncertain significance. Little by little, as the dialect perfected by great men falls from common lips, it loses the accent of vitality; and, lesser scholars, trading upon their master's discoveries, are scarcely conscious how far they have changed his language, till the world finds that it is listening to a dead tongue.

When Michael Angelo died, it was vain to hope that those who came after him could carry forward the sublime style which is associated with his name, and his death, therefore, was the signal and the note of the downfall of the glorious art of Florence. But Venice had never, from the first, so closely associated itself with the higher movement of the intellect, and, therefore, the masters of Venice were able to survive the signs of intellectual decay, and were even helpful in forwarding the revolution by which it was succeeded.

We need not deny the imaginative beauty of Venetian painting in order to acknowledge that its essence lay elsewhere, and that its strength depended, not so much upon the expression of ideas, as upon a surpassing beauty in the rendering of the facts of nature. It was by the studied cultivation, from the first, of these purely naturalistic elements of painting, that the Venetian masters — Titian most of all — were enabled to herald the advent of a new style; and when art passed from Italy to Flanders, the great Flemish painters, with Rubens and Vandyck at their head, could well take from Venice something that should be of service to themselves. And it was from Flanders—as we have already hinted—that the English school borrowed its first lessons. Just as Holbein, a century before, had introduced among us the earlier and more precise style of portraiture, so Vandyck now came with the attractions of a later style, if not to found a national school of painting, at least to establish a standard of taste that should prepare the way for native painters when the time had come for them to arise.

When Vandyck died, Sir Peter Lely stepped into his place, and Lely, in his turn, was succeeded by Kneller, an artist who enjoyed the honour of having been employed at Court during the reigns of five successive sovereigns. But neither of these painters could be said to have very worthily

carried forward the principles which Vandyck had introduced, and, accordingly, when our native artists—Reynolds and Gainsborough—arose, their advent seemed like a new birth for art in England, as it certainly was a new birth for English art.

This is not the time to insist upon the beauty of the work that these men produced. All that we have to note is, that now, for the first time, England possessed a school of painting of her own, and that the departments in which that school can claim pre-eminence, are those whose supremacy Titian's genius had already forecast.

Gainsborough not only holds an equal place with Reynolds as a master of portrait, but he was, in fact, the founder of the modern school of landscape; and, when he died, Reynolds—his rival—praised him as the greatest landscape painter of his time. But it is curious to note—and that is our principal concern to-night—how these professed students of portraiture were already aware of something that lay outside the range of their work, and for the representation of which English art was not yet fairly equipped. It is almost pathetic to meet, in the writings of Reynolds, a constant reference to the masters of Italy—and especially to the style of Michael Angelo—and then to turn from his writings to his canvas, to note how little trace his ardent desire had left upon the result of his own labours. Now and again—especially in his later life—he has attempted to graft some suggestion of allegory upon the proper claims of portraiture; but, even against the will of the author, the essential attributes of his style will assert themselves, and we cannot but feel that the effort yields only a graceful fancy, that has no power of colouring the image as a whole. We find this tendency in Reynolds, because, apart from his great powers, he was an indefatigable and learned student of art. Familiar with all the victories of imagination, he sought to establish in his own country the traditions of a style that he himself could only love and admire from a distance. If we do not find the same tendency in Gainsborough, it is because he was more entirely a child of his generation, and because he accepted frankly, and without misgiving, the limitation of his age. All that Gainsborough does is done by the force of his own genius, and he had no inclination to linger over passed ideals, which lay equally beyond the range of his powers and the taste of his time. In Gainsborough's paintings we may see an exact and brilliant reflection of the resources then possessed by English art; while, in the painting of Reynolds, we may detect something more; and we are able to note the ambition, if not the ability, of the painter to enter into a wider realm. But, before either of these two portrait painters had begun their work, another artist had arisen, through whom we may say that English painting made its first effort to fit its language to the rendering of intellectual ideas. Whatever may be the faults or limitations of Hogarth's genius, his work at least possesses for us the invaluable quality of sincerity. Entirely free from affectation, and unsupported by the inherited traditions of the schools, it permits us to judge, as well in its achievement as in its failure, of the existing resources of English painting, in the first genuine essay that had been made to forge out of lines and colours the means of intellectual expression. Reynolds, with his learning and high culture in the work of past schools, was unable, even when he attempted to touch upon imaginative themes, to conceal those defects of power which Hogarth's painting always frankly confessed. No one was ever more completely under the guidance of imaginative impulse than the author of the "Rake's Progress;" no one, on the other hand, can more justly claim the title of a born painter. But Hogarth's ideas did not rise to sublimity, and his artistic gifts were still closely confined within the scope of realistic effect. He succeeded in his fanciful compositions because he did not misunderstand or misuse the means at his command; and even in those cases where we hesitate to admit the force or the refinement of the invention, the result is still saved from insignificance by the beauty and the delicacy of the painting. He has so long been praised as a satirist, and so justly applauded for those qualities in his art that are not of the essence of art itself, that his gifts as a painter have either not been sufficiently remarked, or have been absolutely ignored. "As a painter," writes Walpole, "he had but slender merit," a judgment which later taste has partly reversed, though there still remains a vague feeling that Hogarth's work does not possess sufficient beauty to be judged by the highest standard. This feeling is, I think, partly dependent upon a confusion between the thought and the measure of its expression: it mistakes the occasional coarseness of the theme upon which he is employed for coarseness of handiwork, but, although this may be true in so far as it regards the qualities of the design, where the expression must share all the defects of the thought, it is absolutely untrue as regards the qualities of his painting. As a colourist, Hogarth will bear comparison with the men of his time, and in his knowledge of tone—the law which regulates the strength of colour in position, and the modifying influence of one tint upon its neighbour—he still remains without a rival in our school.

Hogarth, Reynolds, and Gainsborough. These men are the types of what was of genuine growth in the art of their time. Their achievements were the outcome of a sure process of evolution; in their labours they had the support and guidance of a long and unbroken tradition of executive style. How instinctively, by the light of their genius, they were able to measure the resources at their command, and, with the native prudence of genius, refuse to attempt what lay beyond their powers, we have seen by reference to a different order of art, which others were vainly seeking to establish. Barry, Blake, and Haydon. Such men belong, we may say, to the church militant of art. But it is not to be said of a painter like Barry that, because he fell short of the goal towards which he pressed, that therefore his influence counts for nothing in the history of our school. The time had not yet come for such victories as he sought to win. But whoever hopes for conquest in that vast realm of ideal beauty that he saw only from afar, and with uncertain vision, must strive with something of his noble persistence and undaunted courage. He was the first notable instance, in our school, of a painter devoting himself altogether to the pursuit of a kind of art that offered

no hope of great immediate reward. He may, indeed, have been misled by ambition, but the penalty fell chiefly on himself; and we may forget the frailties of his temper—nay, we may even forgive the faults of his design—in gratitude for the grand and austere example which he set to the students of succeeding generations.

DISCUSSION.

The Chairman said he should be glad to say a word or two, to illustrate a few of the most important points which Mr. Carr had brought forward, before a vote of thanks to him was proposed. The comparative failure of Barry had been ascribed to the temper of the times in which he lived. Now, it had been his (the Chairman's) lot to see most of the European galleries, and the impression made upon him by Barry's pictures was that they were, at any rate, as good as any class of pictures of the same time to be found in any of the great European galleries. He could not call to mind in the Louvre or the Luxembourg, where the French painters of the period were represented, any paintings which could be considered as good or better. He recollected some stiff-looking pictures by David; and, without saying that Barry's were perfect, he certainly thought they were equal to anything to be found in the French school. There were none in the German school of that time so good; the Italian school was as weak as water, and the Flemish was open to the same kind of criticism. It used to be very much the fashion to decry the English school, and within his own recollection the French doubted whether there was any English school at all, until 1855, when we, for the first time, sent pictures to France; and then they awakened in a sort of wonder to the fact that we could show pictures like Landseer's, Mulready's, Leslie's, and others. They even went so far as to say that if Mulready's paintings were put up by auction in Paris, they would fetch as high a price as any by French artists. But looking at what the times were in which Barry lived, what could be expected? At that time we were plunging into the American war; how could painting be encouraged, when the people were taken up with thoughts of how they could fight with their relatives across the Atlantic? A little later, and we had the French revolution, and the political men of those days thought it wise to spend four or five millions in trying to put it down. How could you have paintings in such a time? Then came a series of Irish rebellions, and then Napoleon, with his perpetual wars, and our enormous expenditure to put him down. We had a clause in the treaty of Vienna, that no Napoleon should ever sit on the throne of France, and yet he had seen the Queen of England and her Consort in Paris, embracing one of the same family, as was the fashion amongst monarchs. He thought, therefore, the art of the times was very much influenced by other things besides art. In the first place, the artist must live; and if he believed in another world, he must paint according to his ideas of that world. At the present time, domestic life in England was the dearest thing we had, and almost all our pictures were more or less illustrations of that domestic life. He maintained that our art was quite as good as French, German, or Belgian art, and a great deal better than the Italian. Mr. Carr had referred to the difficulties Barry met with in regard to painting St. Paul's; but that was not an experience peculiar to him. After the Prince of Wales recovered from his illness, and went to St. Paul's to return thanks, the members of the Society subscribed £300 or £400 to put up a memorial window. They got permission of the Dean and Chapter, obtained a design, and thought the window was going to be put up. Then there came a curious set of arrangements for decorating the cathedral, and stopped its adoption. The design of their window represented a miracle above, as the principal subject, and portraits of the Prince and Queen below; but the artist who was entrusted with the grander scheme said that did not suit him at all; he wanted a bigger miracle than their artist had chosen, and from that day to this they had never been able to move a step. There was a force in the Church which could not be overcome, and Barry met with the same kind of difficulty. There was one feature in Barry's paintings which struck him as throwing a light on painters' work in general, and particularly Mulready's, and that was the great earnest sincerity with which he did his best. Almost the last words he heard Mulready utter were these, "If you want to be a painter, you must not spare elbow grease; it is as hard work as anything people have to work for." Miss Amelia B. Edwards, in her admirable novel "Lord Brackenbury," expressed the same idea in these words:—"Art tolerates no divided duty. A man must give his whole soul to it—his whole time—his whole powers of observation, of memory, of comparison, of study. Even so the thing he does must always fall short of the thing he had hoped to do. The greatest painters who ever lived spent their lives, we may be certain, in the vain pursuit of an unattainable ideal. But, at all events, they did so spend their lives. They worked at least as hard as if they had been masons, or plumbers, or joiners." He thought those were words which Mr. Carr himself might have used.

Mr. Hyde Clarke said they must all desire to thank Mr. Carr for the eloquent address he had delivered, and not less to thank the Chairman for his remarks. Perhaps, at one portion of the paper, they might have had the idea that Mr. Carr was underrating Barry in relation to his circumstances and his age, but in the end they must have arrived at the conclusion that he appreciated the artist and his efforts as much as anyone. The question put was, did Barry labour in vain; and did the Society labour in vain in associating itself with Barry in these efforts. It seemed to him that Mr. Carr had, to a great extent, answered that question, and that the Chairman had fully justified the action taken by the Society 100 years ago. It was a long time to look back to, but Mr. Carr had found means to connect their interest even with that remote period. The interesting passage in which he gave the introduction of Martin Archer Shee to the author of the works around that room, brought them into connection with the men of the present day, and the reference to Sir Martin Shee seemed, to a certain extent, to answer the earlier question of the lecturer. He said there was a strange contrast between the two men, and, at that moment, he seemed to indicate a doubt whether Barry had succeeded or failed, and to suggest that he had failed, while Shee had succeeded. Those who had been in Shee's painting-room in the later years of his life, when he was painting portraits at the age of 80, could scarcely consider his career a success. He (Mr. Clarke) remembered Shee saying to him once—"You are often now brought into contact with Mr. Haydon, and he, as a matter of course, abuses the Academy. I recollect when I myself was in difficulties with the Academy. I believe Mr. Haydon's grievance against the Academy is, that on one occasion when he had sent in two pictures to the exhibition, he happened to accompany them, and he heard an Academician call over the staircase to the porter—"Whose paintings are these?" Mr. Haydon's, sir," was the reply. "Mr. Haydon's pictures to the coal-hole!" Shee added that he had a similar adventure. When he was a very young man, and painted some of those great works of genius, which young men are most capable of producing, it so happened that two works he sent to the Academy were rejected, in a year when there were a great many rejected works. The idea occurred to some one of exhibiting all these rejected works, as a challenge to the judgment of the Academy; those who got up the exhibition, sent for his

pictures, and they were to appear; but then it struck him that, after all, though he had been scandalously treated it was perhaps not wise of him, as a young man, to put himself in competition with his seniors, and therefore he sent for his pictures and got them back, not without difficulty, for they were in the catalogue. "Now," he said, "see where Mr. Haydon is, and where I am. I have no doubt if Mr. Haydon had displayed a little more tolerance, he would have been president of the Academy instead of myself." These words had a bearing on the earlier part of Mr. Carr's paper. Which was the man who succeeded—Barry or Shee? Shee enjoyed all the advantages of life; that charm of manner, which remained with him to the last, secured for him every social enjoyment, and advancement in his art to the presidency of the Academy; but he (Mr. Clarke) believed, nevertheless, that the reputation of Barry would remain when the name of Shee would only be remembered by Byron's reference to it? The real test of Barry's position was that which the Chairman had applied to it; he must be judged by the men of his day, and even by those before his day, and he would as willingly compare him with Sir James Thornhill as with any one. At any rate, with careful consideration, no one could fail to arrive at the same conclusion as the Chairman, that in relation to his own day, Barry occupied a truly great position. What did Barry realize? He succeeded no more than Haydon, and than many ambitious men, in accomplishing all the purposes of his ambition, but he did much. He prepared the way for a school of historical art in our own day. He was trammelled by the classical and academical ideas of the day, and those same notions pervaded the French school down to the last works of David. It was only broken by the force of events; although Napoleon was represented as a Roman emperor, it was necessary to present him in his grey coat; it was in reality Napoleon and Wellington who, to a great degree, overcame the tradition of art, and rendered it more natural, and in the respective countries more national. If Barry was not able to do more, they knew by the records of the Society that he was desirous of securing the natural, for there were payments made for models, and every figure was, according to his ideas, presented according to nature. Even if he somewhat failed in his high aims, they must acknowledge his sincere desire to introduce a better element into art. One feature in Barry's work was particularly deserving of notice, that was the introduction of portraits of illustrious men. If there was much absolutely classical, on the other hand how much was there national. He would conclude by moving a cordial vote of thanks to Mr. Carr for his valuable and interesting paper.

Mr. Laing was rejoiced to find that both the Chairman and Mr. Hyde Clarke had spoken in praise of Barry. For the last 50 years he had been in the habit of coming to that room, and those pictures had been lessons to him throughout his life. He was glad also to think there was a movement in the right direction in the Society, and that the cause of art had been brought forward; for he feared that, for some considerable time, they had been paying very little attention to one of the principal objects with which the Society was founded—the encouragement of fine art. He had much pleasure in seconding the vote of thanks, and bearing his humble testimony to the great painter, whose works adorned the walls of the room.

The Secretary (Mr. H. T. Wood) said it might interest the members to see an old volume which the Society possessed, and which he had on the table, containing the MS. of a great deal of Barry's correspondence on the subject of these pictures. It began with the actual letter sent by Barry to the chairman of the committee, stating who the artist was who was willing to undertake the duty of decorating the room, when the ten artists who had been invited had declined. There were many other letters, but, perhaps, the most interesting paper in the volume was an account written by Barry himself of the circumstances which induced him to come forward, and of his object in painting these pictures. When the pictures were cleaned recently, he (Mr. Wood) had made it his business to look through all the old papers, and see if he could collect any facts not already recorded about the pictures. The minutes and other documents, however, had been so frequently gone over before with the same object, that he did not know that he was very successful in finding much that was new, but what little he did find, he put in the form of a pamphlet, which was given to all members who cared to have it. His only object in alluding to it was to say that, coming with no previous knowledge to the study of Barry's history, he could not help arriving at the same conclusion to which Mr. Carr, with his ample knowledge, had been led, as to the extreme sadness of Barry's story. In that room, where they were surrounded by his great masterpieces, where he spent so many hours of hard work, the room to which men brought his dead body that they might pay it some of that tribute of respect which they almost grudged the artist while living, it seemed a pity that they could not awaken more enthusiasm for the artist who was full of such noble aspirations. One could only look back and regret that the fulfilment was not equal to those aspirations. Still the Society of Arts might take some credit to itself for having faithfully discharged the trust left to it by Barry, and for having done what it could for his memory. Even if he had painted the pictures in St. Paul's, which he was so anxious to do, it was doubtful if his fame would have been higher than it was to-day. The Society had always cherished his pictures, and taken such care as it could of them, and now the present Council had undertaken the restoration, the result of which was before them. He would like to add that their Chairman of the evening, Sir Henry Cole, had been a member of the committee appointed to superintend the cleaning, and it was in no small degree to his careful personal attention that so successful a result had been attained.

The Chairman, in putting the resolution, said he had no doubt that owing to this lecture, Barry would be better known than he had ever been before, and that they should not again hear, for many years, the speech made, when some one said he was going to the Adelphi to see Barry—"Barry built the Houses of Parliament, and not the Adelphi." That Society gave prizes and medals for the encouragement of art before the foundation of the Royal Academy, and he could not help thinking that if even the Royal Academy had a series of pictures as good of their kind, or if they could, within a reasonable time, produce a monument of the art of the present day to equal what Barry did in his day, they would have reason to be thankful.

The motion having been carried unanimously,

Mr. Comyns Carr, in response, said he would not detain the meeting, except to say that he did not wish it to be thought that he differed at all in his appreciation of Barry, or of the efforts he made, from the speakers who followed him. He cordially agreed with nearly everything that had been said by those who had, perhaps, spoken more effectively in praise of Barry than he had done. He cordially agreed with the Chairman that his achievements were very great in relation to the art of his time. He had no tendency to underrate the value of our English school; he had tried to point out that at the time when Barry was working there were magnificent achievements produced in that school, and if it was not Barry who produced them, it was because an indomitable current of ideas set in another direction, and because Barry, with heroic effort, was fighting against the stream.

MISCELLANEOUS.

MILITARY DRILL.

Extracts from the Reports of Her Majesty's Inspectors of Schools for the Year 1879, showing the Progress made in Instruction in Military Drill.

"It is to be regretted that military drill is not more frequently taught. Except in towns, there is, I know, some difficulty in the matter, but the managers of schools within a certain area might combine to obtain the services of an army instructor. Many teachers too, who have been volunteers, might, with a little trouble, secure the requisite certificate." — Mr. Bernays, Inspector, Durham district, p. 227.

"Military drill is encouraged in a few schools only. Its effect on discipline is always most beneficial, and I could wish to see it more general. It must, however, be smart and good. Slovenly drill is worse than none." Mr. Colvill, Inspector, Shrewsbury District, p. 240.

"In several schools military drill is taught, and very well taught; it is desirable that it should more often appear in school time-tables. Exercises smartly performed in the playground, generally betoken good order and prompt obedience in the school-room, and they improve the health and carriage of boys and girls."—Mr. Danby, Inspector, Ipswich and Edmonton Districts, p. 270.

"I notice that big boys and girls are often taught exercises suitable only to infants, and that there appears to be a great dearth of originality in the exercises given to infants. Military drill and extension motions are given with great precision in some of the large voluntary schools in the metropolitan district (Stratford, West Ham, and neighbourhood), and in one or two schools the girls acquitted themselves very creditably in the extension motions."—Mr. Helps, Inspector, Chelmsford District, p. 301.

"Drill continues to be well taught in all the schools of the Bristol Board, and in a few others."—Mr. Moncreiff, Inspector, Bristol District, p. 338.

"Military drill is now taught in all the Hull Board schools, securing at once good physical training and an excellent help to school discipline. In voluntary schools its value is not, I regret to say, adequately recognised." —Mr. Stevelly, Inspector, Hull District, p. 388.

"The number of schools where military drill is taught continues to increase. I am sorry to say there are very few schools where sufficient attention is paid to 'position drill' in giving a writing lesson."—Mr. Capel, Inspector, Warwick and Coventry Districts, p. 235.

LONDON WATER SUPPLY.

The evidence taken by the Special Committee of the Society of Arts on the means of protecting the metropolis against conflagration, in 1874, as to the economies derivable from the consolidation of the water companies, entirely bore out the conclusions taken as a basis by Mr. Edmund Smith, and was subsequently referred to in the discussions before the Parliamentary Committees on London Water Supply. In the last report of Lieutenant-Colonel Frank Bolton, the water examiner, which has just been issued by the Local Government Board, later corroborative evidence as to economies consequent on consolidation is brought forward. Colonel Bolton summarises these advantages under the following six headings:—

1. Unification of the metropolitan water supply will ensure a better supply of water, both as to quantity and quality, on more economical terms, and, consequently, at cheaper rates, than can be afforded by several independent companies.

2. It will ensure the introduction of constant service at an earlier date, and at a cheaper cost of alteration and adaption of fittings.

3. It will effect a saving immediately of about half a million sterling, by rendering new works proposed to be carried out unnecessary, and will utilise, for districts requiring extensions, the spare power now existing in other districts.

4. By the re-distribution of several districts into zones of levels, not only will the supply be better regulated, and waste prevented and controlled, but a great saving will be effected in pumping and other distributory expenses, in addition to the economy secured by consolidation of administration.

5. It will enable the metropolis generally, and the heart of London in particular, to be better protected from the effects of fire, by the provision of an ample and an immediate supply of water under pressure, besides the facilities for the concentration of the greatest available pressure on the most valuable and exposed positions.

6. Greater facilities will be afforded to the local authorities in carrying out these sanitary arrangements in their respective districts, which are dependent upon an ample and efficient water supply.

INTERNATIONAL INDUSTRIAL CONGRESS, BRUSSELS.

The Congress of Commerce and Industry was held at the Brussels Bourse, in connection with the International Exhibition. Among the various Governments, that of England was officially represented by Mr. Charles Kennedy, of the Foreign Office, and Mr. John Corbett, M.P. The Congress was divided into four sections:— 1, Political Economy; 2, Commercial Law; 3, Industrial Art; and 4, Applied Science, each of which elected its own officers.

The section of Industrial Art was presided over by **M. Charles Buls**, *echevin* of public instruction for the City of Brussels, **Mr. David Sandeman**, of Glasgow, being appointed one of the vice-presidents. The President gave an abstract of a report which he had drawn up at the request of the organising committee of the Industrial Exhibition of Brussels, in 1874, and in which was developed a programme for the founding of a museum of decorative art.

Art Libraries.

This question was introduced by a report furnished by **M. Havard**, in which he classed these libraries as next in importance to lectures and museums.

M. Platteau said that the library of industrial art attached to the Musée Royal, Brussels, was well attended by workmen, who derived great benefit from it.

The members generally agreed in the advisability of forming a typical library, with as many subsidising libraries as possible, which should generalise art culture.

Schools of Apprenticeship.

M. Platteau, Secretary of the Syndicate of Painting, Brussels, spoke in reference to his paper on schools of apprenticeship, in which he states that the question of teaching the various trades imposed itself on all interested in the progress of industry and industrial art. He insisted chiefly on the necessity of founding schools as complements to the workshop, and of choosing the professors from among practical manufacturers.

M. Fourcault observed that industrial instruction, complete and methodical, was now as necessary as literary instruction. Apprenticeship in the workshop was too long, and schools were required to shorten it. He divided industrial instruction into four degrees, according as it was destined for workmen, foremen, or manufacturers. Then he referred to the necessity of popularising instruction in drawing among workmen, who, for the most part, did not understand a plan or a sketch. Those countries which paid most attention to popularising art applied to industry would take the lead.

Signor Vimercati explained that there existed at Florence a school of industrial art, which was not an annexe of the workshop, but masters were requested to oblige their workmen to follow the instruction. This school gave excellent results, as also did those founded by the Roman Railway Company for the study of mechanics.

M. Oreste Lattès, the Italian delegate, said that, in Italy, the Government undertook to bear two-fifths of the total expense of formation, by the municipalities or the chambers of commerce, of all schools of industrial art, the regulations of which it could adopt. The remaining three-fifths were subscribed by the municipalities and chambers of commerce.

Mr. Fison, of Bradford, described the course of instruction at the Kent College, and the Bradford dyeing school, which latter possessed a museum and a library. He considered that the schools could never be a substitute for the workshop.

Mr. Sandeman traced the creation of technical schools in Glasgow, which originated in a meeting held in 1874. A school of weaving was first formed, then one of dyeing. He preferred the school to the workshop, where it was generally supposed that a lad was at once initiated into the difficulties of the trade, whereas really he spent several years in manual work entirely unconnected with it.

M. Platteau, limiting his observations to the decorative arts, would ask the establishment of technical schools of private initiative, the instructors to be chosen among specialists, supplemented by the most skilful workmen.

Herr Steinacker informed the meeting that in Hungary there was very little industrial life; and the Government, in default of private initiative, had been obliged to found and subsidise the schools.

M. O. Lattès, in response to an invitation from the President, gave some details of technical instruction in Italy. It dated from only a few years back; but an excellent measure of the Government had, in a very short time, tripled the number of these useful institutions. Private initiative furnished at least three-fifths of the expenses of erection, the rest being contributed by the Government, who reserved the right of inspection. The workshop school was not favourably regarded in Italy.

M. Schoy, of Antwerp, asserted that the superiority of Paris was chiefly due to the studious character and "ferreting-out" spirit of her industrial artists. The specialist Parisian workman knew the different styles, and frequented the libraries and museums. If the artistic value of English and German manufactures had increased, this was due to the various special publications which had popularised good designs.

M. Limousin, of Bordeaux, was of opinion that the Government should intervene in the foundation of technical schools. England could afford, up to a certain point, to dispense with Government aid, because of her exceptional resources from endowments. He considered the present snbdivision of trades a matter for regret, but it would increase with improvements in plant. The workman of the future will not produce, but will tend the machine that works, while apprenticeship will be reduced to the minimum of time. This would permit the workman to change with greater ease both master and trade, which might, in some cases, be very advantageous.

The following proposition was then carried unanimously:—"The Congress expresses the hope that the Government will acknowledge that industrial professional instruction and apprenticeship are of social utility; that, in consequence, they continue to subsidise and encourage the present means of instruction, and provide for this instruction in districts where private initiative has not occupied the ground."

Cheap Carriage of Heavy Substances.

This was the first question dealt with by the Scientific Section, under the presidence of **M. Gobert**, Inspector-General, and formed the subject of three papers. The first, by M. Louis Alvin, government mining engineer, attached to the Ministry of Public Works, described several lines of local interest constructed in Belgium with a gauge other than the ordinary narrow gauge. M. J. Moreau's paper dealt chiefly with the economic side of the question, and advocated the construction, not merely of agricultural, but of rural lines, wherever there are small industries, such as stone quarries, which might be extended by their means. The paper of M. Heinerscheid dealt with the transport of heavy goods by rivers or canals, which, he contended, should be so far improved as to render them capable of performing the services that might naturally be expected from them.

M. Finet deprecated the filling up of the canals, and advocated better organisation, so that they might compete with, or at any rate supplement, the railways.

Telephonic Communication.

This was the subject of a paper by M. E. Bède, formerly professor at the Liége University, in which he traced the history of the telephone, and advocated the formation of companies for undertaking telephonic communication in each town. He recommended the use of phosphor bronze for wires instead of iron, phosphor bronze having four times the conductibility of iron, and being from three to four times as strong as steel. Aerial lines had the advantage of being easily inspected, but the disadvantage of being liable to accident, while underground lines were almost free from accident but difficult of inspection. That inventor would render great service to telephonic communication who should devise a cheap method of constructing underground lines, that should at the same time permit of easy and complete inspection.

M. De Locht considered that the contract should be let by public tender to one company only, on condition that the service should be open to all on paying a fee, as in the case of telegraphs.

M. Evrard thought the monopoly should be in the hands of the State, which would extend the system to out-of-the-way corners that offered no inducement to private enterprise.

M. Desguin thought only one company should work a district, otherwise the subscribers of one company would be isolated from those of another. The stimulus of competition between rival companies would be replaced by the interest the company had in increasing the number of its subscribers by perfecting its appliances and improving its service. He was of opinion that eventually all countries would be covered with a vast telegraphic system worked by their Governments; and to attain this result, the State should, for the present, leave each district free to make its own arrangement for telegraphic communication, and establish general telegraphic lines, which might be connected with the district lines, thus preparing the way for a purchase by the Government of the whole system, when the economical conditions of working shall be ascertained.

The discussion was closed by the following resolution chiefly affecting Belgium:—"The Congress, being of opinion that telephonic communications are of general interest, would be glad to see some decision arrived at with regard to the granting of concessions."

The Transmission of Motive Power

was introduced by a paper contributed by **M. Paul Davreux**, engineer to the Musée Royal de l'Industrie, and Professor of Physics at the Brussels Technical School, and **M. H. Evrard**, engineer to the Administration of Belgian State Telegraphs. The authors state that it had been generally admitted that electricity could only be used to advantage in controlling, liberating, or directing other forces; but, since the invention of magneto and dynamo-electrical machines, and the progress made in their construction for electrical illumination, the problem of utilising electricity as motive power had re-appeared under a new form. It was no longer sought to utilise the chemical energy of the battery, so as to transform it into mechanical power, but efforts were made to transport an existing mechanical force from one spot to another, by means of electricity. In the same way, large steam-engines were much more economical than those of small size, motive power might be distributed to the small industries in towns at a low rate, by establishing a central generator of electricity, and a suitable system of conductors. The use of electricity for the transport of motive power presented the following advantages:—The erection is easy; the conductors may follow very sharp curves, requiring less care than pipes transmitting compressed gases, steam or water; there is no danger of explosion, and the air is all the purer for breathing. The authors conclude that electricity will permit of the utilisation, at no very distant date, of all the natural forces, hitherto wasted, such as tides and waterfalls.

Electric Illumination

formed the subject of a paper by **M. Hector De Backer** and **M. Pierre Desguin**, Government Mining Engineers, in which they start with the proposition that a better system of lighting tends to equalise the conditions of working by day and night, and increase the hours of work, thus extending production. The principal qualities which electrical machinery should possess, were: a large yield of electric force with reference to the motive power, regularity of action, small size, low price, and easy and economical maintenance. On the sensitiveness of electric light appliances depended the quality of the light, the generating machine influencing only the cost of production. Generally, the economical problem might be thus stated; for a cost equal to that of the light previously employed, what is the excess of light supplied by electricity? The limit differed with circumstances and appliances, which latter it was for the electrician to select according to each individual case. The method now most generally adopted for diffusion was to use a globe, semi-transparent on its underside and the rest transparent, the rays from which were reflected. The instability arising from electrical machines would diminish as their construction improved; but that arising from want of homogeneity in the carbons could never be entirely prevented. The lamp should not only be perfect itself, but also serve as a compensator to the other irregularities. After describing the various lamps, candles, and regulators, the authors state that, if the carbons were homogeneous, the greatest perfection would be attained by the presence in the circuit, before the lamp, of an independent regulator, which should always allow the same quantity of electricity to reach the light, or the presence of an appliance for abstracting the surplus, if the light were regulated for a minimum of electricity. As to colour, the electric light contained a certain amount of violet rays, which were proved to exert an excellent physiological action, though their influence on the sight was not yet determined. The white colour was perplexing rather than disagreeable; and, for the present, until the eye became accustomed to it, yellow substances might be introduced for absorbing the violet rays. The electric light left the most delicate shades of the same appearance that they have by daylight, it illuminated without heating, and also left almost all the oxygen in the air for respiration.

International Legislation as to Work.

Dr. De Paepe addressed to the Scientific Section a letter, which was ordered to be recorded on the minutes, stating that all academies of medicine, and hygienic societies were unanimous in denouncing, as injurious to public health, and the development of the industrial capacity of operatives, the too early work of children, the absence of a thorough apprenticeship, the exercise of certain trades by women, a too prolonged or intense labour by men, the use of poisonous or injurious substances, inefficiency of ventilation, &c. Certain countries had reformed some of these abuses, but not all; and other countries did not adopt stringent regulations for fear that they should be beaten in competition by those not subject to the same restrictions. He begged that a proposal to take these subjects into serious consideration, with a view to bring about uniform international legislation, such as that which regulates the post, quarantine and maritime navigation, be placed upon the order of the day of the next Industrial Congress.

The Congress terminated by a series of excursions to the principal centres of industry in Belgium, including Antwerp, with its new harbour works, Liége and the Cockerill Ironworks, the Vieille Montagne Zinc Works, the Val St. Lambert Glass Manufactory, Verviers with its cloth works, and the new dam at Gileppe for the waterworks, Ghent, Bruges, and Ostend.

CITY TECHNICAL INSTITUTE.

The first report of the City and Guilds of London Institute since its registration has just been issued. It is in the form of a report by the council of the institute presented to the governors, and adopted by them at the meeting held on the 8th of November. The meeting was held in accordance with one of the regulations of the institute, which required that there shall be a formal meeting of the governors within four months of the date of registration. The institute having been registered on the 9th July, this period expired on the 9th of this month. The report states that the institute has agreed with the Commissioners of the 1851 Exhibition for a site for their future central institution. The Commissioners have granted to the institute a lease for 999 years, at a nominal ground-rent, of a plot of land about 300 ft. long by 110 ft. deep, in Exhibition-road, between the temporary French and Belgian courts, and close to the South Kensington Museum. Mr. Rutherford Waterhouse has been selected as architect, and has been instructed to prepare plans. The report then goes on to refer to the other action of the institute, the details of most of which have appeared in previous reports and in the newspapers. The institute is assisting University College, King's College, the School of Art Wood-carving, the Mining Association of Devon and Cornwall, the Nottingham Institute, Artisans' Institute, the Union of Lancashire and Cheshire Institutes, and the Horological Institute. Some progress has been made towards the erection of a technical college in Finsbury, the council of the institute having agreed with the Cowper-street Schools for the lease of a plot of ground on which the college will be built. The report also gives an account of the progress which has been made in the technical science classes held at the Cowper-street Schools, and in the School of Technical Art, South London.

STATE INSTRUCTION IN DRAWING IN FRANCE.

The report of the Commission upon the instruction in drawing in the French "lycées" and colleges, dated June, 1880, has been lately printed and circulated. It is addressed to the Chamber of Deputies, with whom rests the adoption of the reforms proposed. M. Delaborde is the "President Rapporteur" of the Commission. The system of instruction, which is recommended for adoption in France, is based upon convictions very similar to those which carried the reform in England, of the schools of design, in 1852. Upon the occasion of the opening of an elementary drawing school, at Westminster, in June, 1852, the Right Hon. James Henley then presiding, Mr. (now Sir) Henry Cole delivered an address, in which he showed how the schools of design, instead of teaching the principles and practice of applied art, had been compelled, after 14 years' existence, to virtually commence their careers again, in the character of "mere drawing schools." It had taken the long period of 14 years to arrive at the conviction that, in order to educate a competent designer, the obligation could not be avoided of teaching the very elements of the art—a power of drawing. Under the inspiration of this experience, an official syllabus of instruction in drawing, issued by the Department of Practical Art, then located in Marlborough-house, was prepared by Mr. Redgrave, R.A. Elementary drawing was prescribed to be the imitation of right lines, then of curves, then of copies of leaf forms, the whole forming a first course of what was styled geometrical freehand imitation. As a completion of this first course, the student had to learn some elementary geometrical drawing. He was then deemed sufficiently prepared to enter upon a course of drawing from solid examples of simple form, and to complete his knowledge in this section, he was expected to acquire the rudiments of linear perspective. This initiatory instruction in drawing has, since 1852, remained in force throughout the numerous schools of art and art classes throughout the United Kingdom, which are recipients of Government grants for drawing from the Science and Art Department. Bearing these few facts in mind, the agreement of opinion established between English reformers of a State system of drawing thirty years ago and French reformers at the present time, gives increased interest to the report of the French Commission, which runs as follows:—

"GENTLEMEN,—The problem which is now submitted to you has, in the course of late years, received close attention, and was nearly solved by the members of the 'Conseil Superieur des Beaux Arts' as well as by those who formed the 'Conseil Superieur de l'Instruction Publique.' After interchanging observations and discussing various projects, after labours of successive Commissions composed of both 'Conseils,' an agreement was arrived at upon modifications to be applied to the system of drawing in force in the establishments of the universities, and upon the compilation of syllabuses, according to which the re-organisation of this system should be carried out.

"In order to give early satisfaction to wishes which had been expressed, as well as to ascertain the precise scope of the action to be taken, the predecessor of the Minister of Public Instruction appointed a certain number of inspectors of drawing, whom he charged to proceed with an inquiry upon the present state of affairs in the 'lycées' and colleges, and upon the wants for which fresh measures might be found necessary. All the reports containing the results of this inquiry, undertaken during the first six months of 1879, pointed to the urgency of important reforms. They confirmed what had been previously indicated as being vices or insufficiencies of organisation, and demonstrated the seasonableness of appeals which, from time to time, had been urged for administrative solicitude.

"The Minister of Public Instruction and Fine Arts at once took notice of the reports addressed to him by the inspectors. By a decree, dated 9th July, 1879, the Minister directed a Special Commission to prepare, for submission to the Conseil Superieur de l'Instruction Publique, a project for organising the instruction in drawing in the 'lycées' and colleges; and by the 6th August, 1879, this Commission accomplished its task. The programme, or syllabuses of instruction, prepared by a sub-Commission, especially nominated for the purpose, were approved, on that date, by the entire Commission itself.

"It is these programmes, or syllabuses of instruction, that the Commission, to which I have the honour of being the reporter, has been charged to examine. In generally adopting them in principle, the Commission which embodied them has not felt itself bound to adhere strictly to the text, or to accept all the proposed details. As the Commission, which had in truth initiated the projected reform, it naturally approved, and recommended the 'Conseil Superieur' to do so as well, of a method of instruction which, contrary to usage of long standing, should be based upon giving precedence, so to speak, to the training of the eye before that of hand, a method by which young people would be induced to consider primarily the essential meaning of the forms; and thus, it was decided that pupils should commence their instruction with linear or geometrical drawing. However predominant such a method should be during the three first years of instruction, the Commission had no intention of closely circumscribing the practice of young drawers to the mere tracing of lines, or of estimating the value of their relations one with another. Your Commission was of opinion that, during the first three years' course of instruction, opportunities should be afforded the pupils of practically applying the principles they learnt, and that elementary lessons upon drawing or ornament, the representation of objects according to their appearance, could be usefully given. In this way, whilst deriving real profit, the pupils would be interested in their work, in a way too prolonged exercises in simple drawing of lines could not be expected to affect. Instruction in drawing then, in the 9th, 8th, and 7th classes, would have characteristics of, and should be confined to, the limits we have just indicated; that is to say, the aim of it should be imitation and logical appreciation of right lines, a little later of curves, and later still, the representation of objects involving the simplest geometrical drawing, and the elements of perspective.

"Work of a slightly advanced sort would be required of students in the sixth class. Not only would such have to practice themselves in geometrical and in shaded perspective drawing, of geometrical solids, and of a few common objects, but they would be required to make drawings from ornament in relief, taken from conventional and non-natural objects, such as mouldings, classic honey suckles, dentated ornaments, &c., and, from bas reliefs, inspired by examples of living forms such as leaves, ornamental flowers, &c.; but here again a limit should be fixed, and attempts prevented to imitate, either in or out of classes, any kind of drawing of the human figure.

"Students should not commence this work until they reach the fifth class, and herein lies an innovation in principle which is submitted to you. This innovation, gentlemen, the majority of your Commission does not any longer hesitate to propose; but I am desired to state that in the former Council, and in many Commissions preceding the present, a minority, often, it is true, of very small numbers, was opposed to the principle which the majority of your Commission has seen fit to adopt.

"To justify objections against any system of initial instruction in geometric drawing, the authority, both

of traditional practice of masters of all epochs, as well as of certain precepts, was quoted; against which, nevertheless, it would be easy to adduce other authorities in an opposite sense. Amongst any who had facility in handling the pencil, the necessity was pleaded of developing, from early infancy, the sentiment of the beautiful, of taste, of æsthetic appreciation of form. Now the human figure, such as we see it represented in monuments of antique statuary, and in the works of the masters, being an expression of superior beauty, it was held that the best thing to be done was to bring under the eyes of pupils from the very first day, to the exclusion of all else, models, engravings, photographs, or casts, taken from antique sculptures, or the *chefs d'œuvres* of painters of the Renaissance.

"The holders of a contrary opinion—that is to say, without exception all those of the Commission or above-mentioned 'conseils,' who follow the profession of artist—insisted upon the absolute necessity of there being a primary or grammatical course of teaching drawing. 'Since drawing serves as a mode of expression, in the Fine Arts,' said M. Guillamne, one of the most distinguished members, 'one concludes that art is its unique object, and that it is art which should be aimed at before all other instruction. Nevertheless, one finds that its useful, practical side, the means of precision which it obtains from science, and which serve as indispensable supports, even to the artist himself, are disdained. Before knowing how to draw a line and to recognise in it exactly its value, an affectation for ideal beauty is pretentiously set up. Is there not danger in thus appealing to the creative faculty and independence of sentiment when it would be wiser to attend to the ordering and discipline of the rational faculties? As little as a child may do in a course of instruction in drawing, it would be well for him to imbibe some sure notions, precise and practical, which may serve him during his entire life.'

"Your Commission, gentlemen, in preparing the syllabuses which are herewith submitted to you, has been animated by sentiments like those above expressed; it has had in view the progress of national intelligence.

"Instead of efforts, premature, and necessarily futile, in the presence of objects beyond their comprehension and age, the Commission proposes that beginners should work out very simple exercises, such as almost constitute an elementary mathematical apprenticeship. Instead of a system of instruction subordinated to the preferences or personal conveniences of professors, the Commission asks you to sanction, for general instruction, the establishment of a fixed doctrine, of a curriculum of progressive and scholastic study of drawing. It asks you to disengage the study of drawing from useless difficulties in which it has become environed, and to formularise and renovate its conditions; in a word, to substitute rational and thorough investigation for routine habits, or mere facility of the hand.

"Is it necessary to dwell upon abuses which, in many classes of drawing, have obtained a kind of legal force? It seems that students have too frequently been subjected to trials of patience in a specious mastery over the mysteries of hatching, stumping, or stippling. Here, imbued in the victims of this sad method, is to be found the origin of that disgust, or, at least, weariness of work, which has gone on developing during successive years of study. Something worse than ignorance has arisen, false judgment and complete incapacity, even amongst such as may be naturally endowed to conceive and represent the truth, are the outcomes of this vicious method. Let the most distinguished student in drawing, in his 'lycée' or college, be asked to copy no example dedicated to the glory of *crayon manié*, but a real, solid, object, and unless he be permitted to resort to the mendacious eloquence and babble of the style of drawing he has studied, he must find himself totally unprepared to do as he is told.

"To suppress such artificial customs, to rid, as far as possible, instruction of conventionality, we propose, gentlemen, to set our faces against drawing from the human head until such a time when the pupil, by antecedent studies and acquired experience, may find himself fortified against confusion between the purely mechanical imitation of an example, and the paramount duty of finding out how to faithfully reproduce its essential characteristics.

"It is almost unnecessary to say that the study of drawing from the head having been commenced in the 5th class, that of the entire figure will follow in the more advanced classes. To drawing from the human figure, and to the study of the various parts, will be added in the 4th, 3rd, and 2nd classes, graduated studies of agricultural fragments, of decorative figures, &c. At length, besides developing and applying preceding studies in the classes of rhetoric and philosophy, the new programme proscribes that pupils in both these last-named high classes, shall practise landscape drawing from copies, and, further, if circumstances permit it, sketches from nature, trees, buildings, &c. Circumstances permitting, a few attempts might be made in the rhetorical and philosophical classes in studying the human head from life.

"The syllabus of the drawing courses in classes of special secondary instruction, has not appeared to your Commission, to demand exceptional treatment different from that laid down for classical classes of secondary instruction, excepting, in so far as appertains to work to be done by students in special classes, where, a necessary division arises between drawing done without, and that done with the aid of instruments, and in which architectural or machine drawings of an advanced style forms part of the studies.

"For all other classes, the course of study is common to both sets of pupils. Both will be required to follow the same track, will be subject to the same tests, will study from the same models and copies; photographs on account of their negative character, and being liable to be completely misunderstood by beginners, are rigourously interdicted from the category of examples. The only exception in regard to photographs will be made as respects those from pen and pencil drawings of the masters, because in them, precise lines of the master hand are reproduced, and define such methods of drawing as are not to be expected in photographs from sculptures and paintings.

"The prohibition of photographs as examples, excepting in the cases above indicated, is a step to which your Commission attaches great importance. On this point it has expressed an opinion of conformity with that of the unanimity of the majority of the preceding Commissions. As to the establishment, proposed by the more recent of these, of a course of twenty lessons for secondary special instruction, and of fifteen lessons upon the general history of art, your Commission has been forced to the conclusion that it was impracticable. It has considered on one hand that the two hours allowed in the 'lycées' and colleges for drawing could not, without difficulties, be regulated to admit of the special courses in question, and it feared on the other hand that in the majority of cases the teaching staffs might, in the absence of efficiently tested ability to impart such instruction, as that necessary in a comprehensive history of art embracing all epochs and successive phases of art in different countries, be unable to meet the requirements expected of them.

"I have attempted, gentlemen, to bring together the considerations which have influenced us in determining the choice and compilation of the various articles composing the syllabuses of instruction, upon the adoption of which you are asked to deliberate. I should only add that in deciding to recommend the adoption of a progressive course of instruction in drawing, based upon an elementary training in geometry, your Commission has, beyond such convictions as theory alone

might carry, felt the benefit and utility which arise from a regulated and practical order of stages of instruction.

"From statistics furnished by the Director of Secondary Instruction, it appears that about a third of the students in our 'lycées' are receiving special instruction, and that of the remainder, the half, at least, of the 2nd and 3rd, do not rise beyond the 4th class. 'Thus,' as the Director of Secondary Instruction says, 'the half of our students are destined for commerce, for industrial persuits, for manufactories, either as managers or workmen. Consequently, if instruction in drawing 'the figure from copies' be made the foundation of a scheme of tuition, the half of the students would miss those preparatory courses of precise drawing which are more closely allied to different industrial careers.

"How can one escape from being struck by the gravity of such a danger? The means of avoiding it lies in the very method and projected re-organisation of the instruction in drawing which your Commission recommends you to adopt. This method entails no sort of compromise. The vocation, otherwise exceptional, of those students who may some day become artists is not endangered, since the scientific principles they will acquire the knowledge of, will be certainly called into play. The more general interests of those who in the course of their lives may be called upon to express their ideas by more adequate means than by speech or writing, will not be jeopardised, and finally, from the philosophical point of view, a more precise notion of the conditions and uses of the art of drawing will be disseminated. In a single word, instruction in drawing thus understood and followed, would have the advantage of at once imparting to pupils a logical education, and of usefully preparing the way of their future."

To this report are appended the syllabuses proposed for the various classes in the lycées and colleges, which in a measure correspond with the stages of instruction set forth in the official Art Directory of the Committee of Council on Education.

GUM HOGG AND ITS USES.

Under the name of Gum Hogg, a substance is described in the *American Journal of Pharmacy*, of which it is stated that the botanical source is unknown. It appears to be of a similar nature to tragacanth, taking up a large proportion of water, though it is not absolutely soluble. An experiment in this direction showed that, after being in cold water for twenty-four hours, it swelled up into a soft white transparent mass, occupying the lower half of the vessel in which it was placed; when agitated, the mass showed no disposition to form a uniform mucilage, but separated into small, soft, transparent, and rather granular fragments resembling pounded ice; this subsided at the bottom of the vessel again when it was set at rest. A second portion of the gum, by prolonged boiling with water, gave the same result as obtained with cold water.

The commercial history of this gum in North America is very interesting. It appears to have been introduced into Salem, Massachussets, about thirty years since. At that time Salem was the head-quarters of the East India trade, and this gum came with a lot of tragacanth imported to that place from Calcutta. It was supposed that it might be used in place of tragacanth, as a cheaper article, by the shoemakers. It, however, came into the hands of a noted drug garbler of the place, and was rejected by him immediately as an inferior gum. It was next shipped to Boston for sale, and after a number of ineffectual attempts to foist it on the market, it was finally put up at public auction and sold for two or three cents a pound to one of the principal booksellers. The purchaser made a number of ineffectual attempts to utilise it for different purposes, and finally, somewhat disgusted, placed it in the hands of a Prof. Jackson, a chemist, in the neighbourhood of Boston; he made several experiments with it, and discovered its property of forming a good non-adhesive mucilage, when boiled with an alkali. It was soon after utilised for the manufacture of marbled paper, which was just then becoming known in the country. Gradually the secret became known, and as there was a slight demand for the article at different times, small lots were brought into the country. Up to the time of the experiments being made the gum had received no name, but aferwards it was known through the trade by that of gum hogg, and it is believed that the name was given by Prof. Jackson, on account of its obstinancy in resisting the different efforts for its solution, and thus behaving like a well-known animal of similar perverse and wilful habits.

Of late years, the gum has gone considerably out of use on account of the irregularity and scarcity of the supply. The process in which this gum takes a part in the manufacture of marbled paper consists of staining the paper and the edges of books in a variegated manner. The gum is first allowed to soak in cold water until swollen, and then boiled with a weak solution of pearlash until a thick consistent mucilage is obtained, which is strained. This forms the basis or vehicle for receiving the colours and transferring them to the paper, and is placed in a shallow tank about five feet long, three feet wide, and four inches deep. This body must be removed as often as fermentation in the mucilage renders it liquid. In cold weather this is not so frequent, but in hot weather it must be replaced with fresh at least twice daily. The colours used are the ordinary paint colours ground to a cream with thin mucilage of gum arabic. The workman standing over the tank first takes a large brush with spreading bristles, and, dipping it in his colour, sprinkles it over the surface of the tank by twirling the handle between his hands. The value of the mucilage is now shown, for the colour does not either mix with it or spread over its surface, but retains the circular form the drops would assume upon first striking a plane surface. The first colour is then followed in a similar manner by a second, using a fresh brush, and thus in turn by a third, and so on, at the pleasure of the operator, each particular drop showing no disposition to mix with its fellow. The pattern thus made is mostly of round drops, but should it be desired to vary it, combs of different degrees of fineness are drawn in different directions gently over the surface, producing beautiful wavy lines and figures. The paper is now floated gently over the surface of the tank for a few seconds, where the colour is transferred from its surface to that of the paper, and, after being hung to dry, is burnished by hot steel rollers; no particular quality of paper is needed, the only requisite being it should not be too highly calendered. A smooth piece of board is now drawn over the surface of the tank, when it is ready for a fresh operation. The edges of the books are stained in a similar manner, the book being taken unbound and pressed between boards tightly together, so that none of the colour shall penetrate beyond its surface; they are afterwards, when dry, burnished by a hot iron tool by hand. The products afforded by the process are of infinite variety, and, as can be imagined, no two products are ever exactly alike, and, by varying the colours, an almost endless kaleidoscopic change can be produced.

THE MANUFACTURE OF PORCELAIN IN KIANGSI.

The province of Kiangsi has, for some time past, been celebrated for its production of chinaware, and the trade in this article is steadily increasing. The great bulk of it is carried in native craft direct from the factories to various points in China, up and down the

River Yang-tse-Kiang, and along the coast even as far as Canton; a large quantity is shipped *viâ* Kiukiang for Shanghai for transhipment to northern ports, but chiefly Tientsin. The great factories for the manufacture of chinaware are at a place called Kingtê-chên, but it is a curious fact that none of the clay employed is found in that district; this is all imported from districts in the neighbourhood of Nankang-fu, Kwangsin-fu, and Jaochow-fu. The chief reason for the selection of Kingtê-chên as a site on which to erect porcelain factories so extensively, was on account of the water found there, which, because of its cleanness and clearness, and being impregnated with salts, was considered most fit to purify and refine the clay, and unite its particles. It is said that this clay is a composition, and that two or three hundred years are required to prepare it; this, however, cannot be so, as in that case, the ware would be neither so common nor so cheap. It is conveyed from the various quarries in the district by boats and small junks, and washed, in order to purge it from any different earth, then brayed to a small powder, which the workmen continue pounding for a long time. Of this powder a paste is formed, and this is kneaded and beaten in order that it may become softer, and that the water may be incorporated with it. After the clay is thoroughly moulded, it is formed by the wheel into any shape or style that the maker pleases. When the work is satisfactory, the vessel is exposed to the sun morning and evening, but removed as the day gets warmer for fear of its being warped. The various articles are thus dried by degrees, and as soon as the ground is considered fit to receive colours they are painted, and in order to give the vessels and colours a better lustre, or a highly enamelled appearance, a very fine layer of the same porcelain is made, and the whole work washed with it. This gives that particular whiteness and lustre to be seen in the very finest ware. The next process is to put the articles into a furnace, and bake them with a constant but gentle heat, which will not break them. After they have acquired the proper consistency, they are allowed to remain some time before being withdrawn, to prevent any damage by a too sudden exposure to the cool air. The value of this chinaware depends very much upon fancy; but it is generally conceded that three things combine to make any one of the articles complete, viz., the fineness and rare finish, the painting and designing of the figures, and the shape and fashion of the work. The fineness may be tested by the transparency which is discernible chiefly about the edges of the article. The whiteness is often confounded with the varnish, but it is said that age in time makes a plain distinction, for the varnish will tarnish in the long run, and the whiteness becomes more apparent. The smoothness and fineness consist in the brightness of the varnish and evenness of the work. The former must not be too thick, because in that case there will be a crush upon it, and it will shine too much, and the surface is only perfectly even when it has not the least rising or the smallest depression to be seen, although few pieces are without some of these defects. In colouring the chinaware, imperial yellow, milky white, red, and grey are the favourite grounds on which are painted figures, landscapes, flowers, trees, birds, and arabesques, though turquoise blue, pale pink, mazarine blue, and sage green grounds are often employed. Arabesques are more frequently met with than any other style of ornamentation, and they are generally in borders, but are also used for enriching the whole surface of vases, consisting of fanciful and ideal mixtures of all sorts of figures, real and imaginary, often truncated and growing out of plants; also all sorts of plants, and involved and twisted foliage. Many of the designs in painting are mean and common, flowers and trees are often fairly well done, but the figures of men are, as a rule, monstrous, whereas other pictures are bold and well proportioned. The finest specimens are selected by an official for the Court at Pekin, and these are called Imperial ware ("Kuan Yao"), and each article bears a "Kuan Yin" or furnace stamp upon the back, which merely gives the year of the dynasty reigning at the time of manufacture. All the other ware is designated "Min Yao," meaning the ware made for the people; that is of a common kind. Several samples of the Kiukiang porcelain were exhibited in the Philadelphia and Paris Exhibitions of 1876 and 1878.

GENERAL NOTES.

Technical Education.—Sir John Bennett has addressed a letter to several of the morning papers, stating that he is about to bring forward a resolution at the Common Council, that a grant of ten thousand guineas be made to the City and Guilds of London Institute for the promotion of Technical Education. It will be remembered that although the Corporation has always had representatives on the governing body of this institute, they have not as yet contributed anything towards its funds.

Cutlers' Company.—A course of lectures, on subjects connected with the materials used in the manufacture of cutlery, is arranged for delivery in the Cutlers'-hall in December, 1880, and January, February, and March, 1881. The first lecture will be by Sir Henry Bessemer, "On the Manufacture and Uses of Steel, with Special Reference to its Employment for Edge Tools." A subsequent lecture will be given by Prof. Huntingdon, of King's College.

Electric Light Wires.—A letter from Mr. James Harrison, superintendent of the New York Board of Fire Underwriters, dated October 21, is printed in the *Scientific American*, which contains an account of an accident occasioned by electricity from an electric light wire in the office of Messrs. Silcox and Co., of New York:—"One day, either Monday or Tuesday last, some persons on the roof of one of the intervening buildings, dropped an electric light wire upon that of the telephone wire of Messrs. Silcox, bringing the two wires in contact. The effect rather astonished the people in the office. Flames burst forth from the telephone instrument on the wall, producing such an intense heat as to entirely destroy the magnets." The editor points out that such an accident as this may be prevented by covering the electric light wires or the telephone magnets with insulating material, and urges the necessity of this precaution.

Edinburgh School of Cookery and Domestic Economy.—The sixth session of this school, and the first under its extended name, was opened by Dr. Beddoe, F.R.S., president of the Health Section of the Social Science Congress. The subjects to be taught during the session 1880-81 are:—I. Cookery (demonstration and practice). II. Ironing, clear-starching, and the French method of doing up fine lace. III. German method of cutting out dresses, &c. IV. Ambulance lectures on first aid to the injured. V. Physiology and health. A small library of the leading books on food, cookery, and physiology has been formed for the use of students. The Hon. Secretary is Miss Guthrie Wright, 6, Strandwick-place, Edinburgh.

Porcelain Clays.—Prof. Wurtz, who, a year or two ago, examined some of the so-called porcelain clays used at Arita, found that they were no clays at all in the scientific sense of the term, and hence drew the startling conclusion that the Japanese porcelain is not prepared from china-clay. Many other analyses, however, have been made by Prof. R. W. Atkinson, formerly of University College, London, and now of the University of Tokio. These analyses, which have lately been published by the Asiatic Society of Japan, do not, on the whole, bear out the views of Prof. Wurtz. At any rate they show that the composition of some of the clays of Japan is very similar to that of ordinary Kaolin. One of the Satsuma clays, for example, contains 51·79 per cent. of silica, 30·91 of alumina, and 11·74 of combined water. It is true, however, that some of the other analyses agree with those of Wurtz; indeed, one of them shows as much as 81·86 per cent. of silica. But, notwithstanding such analyses, it is clear that true porcelain-clay is used by some at least of the Japanese potters.—*The Academy.*

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock. For meetings previous to Christmas:—

December 1.—"The Photophone." By Professor Alexander Graham Bell. F. J. Bramwell, F.R.S., Chairman of Council, will preside.

December 8.—"London Fogs." By Dr. Alfred Carpenter. Edwin Chadwick, C.B., Vice-President of the Society, will preside.

December 15.—"The Use of Sound for Signals." By E. Price Edwards, Secretary to the Deputy-Master of the Trinity-house. Dr. Tyndall, F.R.S., will preside.

For Meetings after Christmas:—

"Buying and Selling; its Nature and its Tools." By Prof. Bonamy Price. On this evening Lord Alfred S. Churchill will preside.

"Causes of Success and Failure in Modern Gold Mining." By A. G. Lock.

"The Participation of Labour in the Profits of Enterprise." By Sedley Taylor, M.A., late Fellow of Trinity College, Cambridge.

"The Gold Fields of India." By Hyde Clarke.

"Flashing Signals for Lighthouses," By Sir Wm. Thomson, F.R.S.

"The Present Condition of the Art of Wood-carving in England." By J. Hungerford Pollen.

"Five Years' Experience of the Working of the Trade Marks' Registration Acts." By Edmund Johnson.

"Trade Prospects." By Stephen Bourne.

"The Manufacture of Aërated Waters." By T. P. Bruce Warren.

"The Compound Air Engine." By Col. F. Beaumont, R.E.

"Improvements in the Treatment of Esparto for the Manufacture of Paper." By William Arnot, F.C.S.

"Deep Sea Investigation, and the Apparatus used in it." By J. G. Buchanan, F.R.S.E., F.C.S.

"The Discrimination and Artistic Use of Precious Stones." By Prof. A. H. Church, F.C.S.

"Forest Conservancy in India." By Sir Richard Temple, Bart., K.C.S.I.

"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

"Indian Agriculture." By W. R. Robertson.

"Trade Relations between Great Britain and her Dependencies." By Wm. Westgarth.

"The Languages of South Africa." By R. Cust.

"The Loo Choo Islands." By Consul John A. Gubbins.

Cantor Lectures.

Monday Evenings, at eight o'clock. The First Course, on "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." Five Lectures, by Prof. A. H. Church, M.A. Oxon., F.C.S.

Lecture II.—November 29.

Vitreous, plumbiferous, boracic, and felspathic glazes and enamels. Iridescent and metallic lustres, and colouring substances.

Lecture III.—December 6.

Stoneware and other wares glazed with salt.

Lecture IV.—December 13.

Soft paste porcelains, European and Oriental.

Lecture V.—December 20.

Hard paste porcelains, Chinese, Japanese, and European.

The Second Course will be on "Watchmaking," by Edward Rigg, M.A. Three Lectures.

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Three Lectures.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

Admission to Meetings.

Members have the right of attending all the Society's meetings and lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 29th...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. A. H. Church, "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." (Lecture II.)
British Architects, 9, Conduit-street, W., 8 p.m. Mr. E. C. Robins, "Sanitary Science in its Relation to Civil Architecture."
Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Presidential Address, by Mr. A. H. Bailey.
Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, Nov. 30th...Royal, Burlington-house, W., 4 p.m. Anniversary Meeting.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Renewed Discussion upon Mr. Maxwell's Paper, "New Zealand Government Railways," and on Mr. Mosse's Paper, "Ceylon Government Railways."
Zoological, 11, Hanover-square, W., 8½ p.m.

Wednesday, Dec. 1st...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Prof. Alexander Graham Bell, "The Photophone."
Geological, Burlington-house, W., 8 p.m.
Entomological, 11, Chandos-street, W., 7 p.m.
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Mr. C. B. Allen, "Note on the History of Saffron." 2. Mr. E. M. Holmes, "The Use of Saffron in Pharmacy."
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Rev. Dr. Hooppel, "The Explorations of the Roman Station of Vinorium (Binchester)." 2. Dr. Wake Smart, "Roman Remains at Nursling, Hants."

Thursday, Dec. 2nd...Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. Frederick Townsend, "An *Erythræa* new to England." 2. Dr. Maxwell Masters, "The Conifers of Japan."
Chemical, Burlington-house, W., 8 p.m. 1. Mr. W. Ramsey. "Communication from the Laboratory of the University College, Bristol." 2. Laura Mauda Passavant, "The Specific Volume of Chloral." 3. Mr. J. W. Hamilton, "The Formation of Carbon Tetrabromide in the Manufacture of Bromine." 4. Ballot for the Election of Fellows.
South London Photographic (at the House of the Society of Arts), 8 p.m.

Friday, Dec. 3rd...Philological, University College, W.C., 8 p.m.
Geologists' Association, University College, W.C., 8 p.m.
Archæological Institute, 16, New Burlington-street, W., 4 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,463. Vol. XXIX.

FRIDAY, DECEMBER 3, 1880.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

THE PHOTOPHONE.

A selection of the diagrams used by Professor Graham Bell, to illustrate his paper on the Photophone, will be reproduced in next week's *Journal*. There has not been sufficient time to allow of the blocks being prepared for the present issue.

CANTOR LECTURES.

The second lecture of the first course was delivered on Monday, the 29th ult., by Prof. A. H. Church, M.A., F.R.S., on "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." The lecture was devoted to the treatment of glazes, enamels, lustres, and colouring substances. The lectures will be printed in the *Journal* during the Christmas recess.

PRACTICAL EXAMINATIONS IN VOCAL AND INSTRUMENTAL MUSIC.

The next examination at the Society's house will be held during the week commencing January 10th, 1881. Particulars will be forwarded on application to the Secretary, Society of Arts, John-street, Adelphi. No names can be received after the 24th December, 1880.

PROCEEDINGS OF THE SOCIETY.

THIRD ORDINARY MEETING.

Wednesday, December 1st, 1880; F. J. Bramwell, F.R.S., Chairman of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Begley, Mrs., 26, St. Peter's-square, Hammersmith, W.
Fall, Thomas, 9 and 10, Baker-street, Portman-sq., W.
Fisher, Thomas, Church Entry, 75, Carter-lane, E.C.
Harman, Godfrey Charles, 22, King-street, Portman-square, W.
Macauley, Lieut.-Colonel George William, 43, Craven-road, W.
Stubs, Peter, Statham-lodge, Warrington.
Symmons, Edmund, Eagle-house, Hermon-hill, Woodford.
Walker, Robert, J.P., Kidwells-park, Maidenhead.
Waterhouse, Sebastian, 37, Catherine street, Liverpool, and Windham Club, S.W.
Williams, William Henry, 23, Holland-park, W.

The following candidates were balloted for, and duly elected members of the Society:—

Allcock, Arthur Thomas, 5, Spring-gardens, Newark-upon-Trent.
Atkinson, Frederick William, 137, Leadenhall-street, E.C.
Aylmer, Capt. John Evans-Freke, M.P., Aylmersfield, Streatham.
Baillie, J. H., 15, Old Bond-street, W.
Baxter, F., South Eastern-wharf, Park-street, S.E.
Bell, R., 83, Knightrider-street, E.C.
Bennet, Peter Duckworth, Edgbaston, Birmingham.
Biggs, Benjamin, 3, Laurence Pountney-hill, E.C.
Blackwood, Richard, 96, Cromwell-road, South Kensington, S.W.
Blamires, Thomas Howard, Close-hill, Lockwood, near Huddersfield.
Blyth, James, 31, Park-terrace, Regent's-park, N.W.
Capel, Frank C., The Mount, Wilmington, Kent.
Carpmael, Alfred, 1, Copthall-buildings, E.C.
Clark, William Timbrell, Kilsby, near Rugby.
Collington, James B., Beeston, Nottinghamshire.
Comerma, Capt. Andrés A., 48, Macfarlane-road, Shepherd's-bush, W.
Cottew, William Stokes, The Bank, Tottenham.
Cranwell, William B., 42, Portsdown-road, W.
Crookenden, Isaac Adolphus, Marlborough-house, Blackheath, S.E.
Deane, James Parker, D.C.L., Q.C., 3, Paper-buildings, Temple, E.C., and 16, Westbourne-terrace, W.
Deaville, Rev. Joseph Gibson, Agincourt-villa, Bury, Lancashire.
Dewrance, John, 176, Great Dover-street, S.E.
Eaton, Francis James, Albert-road, Hesketh-park, Southport, Lancashire.
Emptage, Daniel, Dane-hill Sanitary Works, Margate.
Estcourt, Roland M., Local Government Board, S.W.
Evans, Lieut.-Colonel John, Highfield, Derby.
Ford, George Benjamin, 196, Westminster-bridge-road, S.E., and 9, Cuthill-road, Denmark-hill, S.E.
Freeman, William George, 44, Kensington-square, W.
Gordon, Surgeon-General C. A., M.D., C.B., Q.H.P., 70, Cambridge-gardens, W.
Grant, Sir John Peter, K.C.B., G.C.M.G., The Doune of Rothiemurchus, Aviemore, N.B.
Greenall, Lieut.-Colonel James Fenton, Lingholme, Derwentwater, Cumberland.
Guest, Montague J., M.P., 3, Savile-row, W., and Bere Regis, Blandford, Dorset.
Guthrie, Herbert, 32, Brown-street, Manchester.
Hall, Alexander Lyons, F.R.G.S., Lyon's-court, Ladbroke-road, Holland-park, W.
Harper, George Thomas, Southampton.
Harvey, William Charles, 12, Old-square, Lincoln's-inn, W.C., and 8, Warwick-road, Maida-hill, W.
Haynes, F., Superintendent's Office, Telegraph Department, G.W.R., Taunton.
Heyworth, Lieut.-Colonel Lawrence, Wain Vawr, near Newport, Monmouth.
Hickman, Alfred, Goldthorn-hill, near Wolverhampton.
Homan, Ebenezer, Friern Watch, Finchley, N.
Hulse, Joseph, Dresden, Longton, Staffordshire.
Isaac, Benjamin, 102, Piccadilly, W.
Johnson, Walter Claude, Rivoli, Old Charlton, Kent.
Judson, Frederick Henry, 77, Southwark-street, S.E.
Keyser, Charles Edward, M.A., F.S.A., Merry-hill-house, Bushey, Herts

Lambe, J. B., 199, Upper Thames-street, E.C., and 427, New-cross-road, S.E.
Lightfoot, Thomas Bell, 2, Granville-park, Blackheath, S.E.
Lingard-Monk, Richard Boughey Monk, 4, Westminster-chambers, S.W., and Fulshaw-hall, Wilmslow, Cheshire.
Lovell, Richard J., 48, Oakley-road, Canonbury, N.
McDonald, James E., 4, Chapel-street, Cripplegate, E.C.
Marriner, William Tyler, Eton-villa, King Edward's-road, South Hackney, E.
Marshall, Alfred, The Villa, Muswell-hill, N.
Martin, John Cowdery, White Lead Works, Ossory-road, Old Kent-road, S.E.
Mineard, George Edward, 57, Warwick-road, South Kensington, S.W.
Moser, Charles E., Brooklyn, 75, Upper Tulse-hill, S.W.
Neal, James, 21, Lime-street, E.C.
Nyland, James, 42, Burlington-road, St. Stephen's-square, Bayswater, W.
Paddon, Samuel Wreford, Brooklyn, Chislehurst.
Pearson, Joseph Hickman, J.P., The Leveretts, Handsworth, near Birmingham.
Pfoundes, Charles, F.R.G.S., M.R.S.L., 1, Cleveland-row, St. James's, S.W.
Pickering, Charles William Harrison, J.P., New Brighton, Cheshire.
Pinnock, Henry, J.P., Beechwood, Newport, Isle of Wight.
Pursell, John Roger, Kingston-road, Merton, Surrey.
Puzey, William, 5, Aldermanbury-postern, E.C.
Quincey, Edmund de Quincey, 76, Avenue-road, Regent's-park, N.W.
Ravenscroft, Sidney Horace, Powis-lodge, Haverstock-hill, N.W.
Robinson, John, F.G.S., Kingscote, East Grinstead.
Robson, John, Tynemouth-road, The Green, Tottenham.
Rogers, J. H., Moore-place, Esher, Surrey.
Rothwell, Richard, 45, Holland road, Kensington, W.
Rudd, William Albert, Gloucester-house School Science and Art Classes, Dodington, near Sittingbourne.
Simpson, George Palgrave, 2, Mount-terrace, Richmond, Surrey.
Sonnenthal, George, 85, Queen Victoria-street, E.C.
Southee, Arthur Philip, Mount Edgecumbe, Ramsgate.
Squire, John Barret, Worston-house, Durning-road, Liverpool.
Stanger, George Hurst, Queen's-chambers, North-street, Wolverhampton.
Stone, James Henry, J.P., Cavendish-house, Grosvenor-road, Handsworth, Birmingham.
Tarr, William, 83, Knightrider-street, E.C., and Ferndale, Walton-on-Thames.
Trench, Lieut.-Col. the Hon. William Le Poer, R.E., 3, Hyde-park-gardens, W.
Verity, John, 31, King-street, Covent-garden, W.C.
Warrick, Robert Betson, 27, Woburn-square, W.C.
Weager, James H., 26, Leadenhall-street, E.C., and Tottenham.
Weir, James, 49, Jamaica-street, Glasgow.
Wells, Charles A., 1, High-street, Lewes, Sussex.
Wing, John Unwin, Brinkburn-grange, Sheffield.
Wyatt, Vitruvius, Gas Light and Coke Company, Beckton, E.
Ziegler, David, 7, Upper Woodland-terrace, New Charlton, Kent.

The **Chairman** said it was the duty of a chairman, as a rule, to introduce the reader of a paper to the meeting, but this evening it was quite superfluous for him to do so. He should have to accuse the members of the Society of Arts of want of gratitude, and even of not belonging to civilised society, if he assumed that Prof. Graham Bell required any introduction, because he was prepared to say that Prof. Graham Bell, whose paper on the telephone they had listened to with so much pleasure, two years ago, had made for himself a world-wide reputation in all places claiming civilisation. In that room, Professor Bell had, two years ago, brought before their notice an account of the telephone, with which they were so much interested. They were all, of course, glad to find that he had not rested on the reputation he then made, but that he had continued the devotion of his mind in that particular direction, the result of which had been the production of this marvellous instrument, the photophone. He would not waste any further time, but simply call upon Prof. Graham Bell.

The lecture was on—

THE PHOTOPHONE.

By Professor Alexander Graham Bell.

I had hoped to have been a listener here to-night instead of a speaker. While I was uncertain whether my engagements abroad would permit me to be present in England, I still intended to make every effort on this occasion to hear Mr. Preece read the paper he had promised. I am sorry that circumstances have disappointed me in hearing another speak on this subject; but I need hardly tell you how much pleasure it gives me to come again before the members of the Society of Arts.

The facts of science are often more marvellous than the imaginations of fiction, and to-night I have to bring before you one more illustration of the truth of this saying. That we should be able to talk along a beam of light as we talk through a speaking tube, seems almost too marvellous for comprehension; but you are aware that everything is easy when you know how it is done, and it will be my duty to-night to explain to you the *modus operandi* by which this wonderful result is obtained—to show you how we can produce the sounds of articulate speech in distant places by the simple agency of a quivering beam of light. It will be necessary, however, before entering on this subject, to speak of the curious discovery that was first announced to the world in February, 1873, by Mr. Willoughby Smith, who discovered that the rare and curious element, selenium, has its electrical resistance affected by the influence of light; that when light falls upon selenium a free passage is opened up among the molecules of a current of electricity, whereas, in the dark, the resistance of this substance is enormous. We know that selenium was discovered in the year 1817, by the great chemist, Berzelius, in attempting to discover tellurium in the residues obtained in the manufacture of sulphuric acid. He found that it was a non-conductor of electricity; but Hittorf discovered, in 1851, that selenium became a couductor of electricity in one of its allotropic forms. When selenium is fused, and slowly cooled from the fusing-point, it is found to be in a crystalline condition; in this condition it is a conductor of electricity at ordinary temperatures. To Mr. Willoughby Smith, and to his assistant, Mr. May, is due the discovery that I here allude to, that the conductivity of selenium is affected by light. I hope to have an opportunity of exhibiting its effect to you to-night, by throwing on this screen a ray of light reflected from the mirror of a Thomson galvanometer. A piece of selenium, which is in a

parabolic reflector at the end of the room, is connected in the circuit with this galvanometer and a rheostat. The resistance of the selenium is balanced, so that the spot of light should not be deflected to any material extent when a current of electricity passes through the circuit; but on throwing light upon the selenium, we shall immediately obtain a marked deflection of the galvanometer; or, in other words, of the spot of light. We shall have to be very still until the spot of light comes to rest, as the slightest movement on the platform will disturb this delicate instrument — the galvanometer. I have in my hands a little mirror, by which I can throw a beam of light on the screen, and if the experiment should prove successful, we shall be able to obtain a deflection of that beam of light. I may say that this is a difficult and delicate experiment, and may not at first be successful, but I hope to obtain a deflection of that spot of light. You observe the moment the light is thrown into the parabolic reflector the resistance of the selenium is reduced, and the deflection of the galvanometer occurs. You will understand that the action of the light is to cause a diminution in the electrical resistance of the selenium, so that the resistance which was balanced while the selenium remained in the dark, was no longer balanced when the light was thrown upon the selenium.

Although, as I have said, selenium was discovered by Berzelius in the year 1817, more than half a century passed before this substance was regarded as anything more than a chemical curiosity. Mr. Willoughby Smith was the first, so far as I know, to attempt to utilise it in the arts. On account of its enormous resistance to the passage of the electric current, he thought it might be used in his system of signalling and testing during the submersion of submarine cables. For this purpose, he made experiments on the Atlantic cable at Valentia, and it was during the course of these experiments that the discovery was made, that the electrical resistance of this substance was affected by light. The mode in which selenium was used consisted of a bar of selenium with platinum terminals fused into the ends for purposes of connection, and placed inside a glass tube, hermetically sealed. When experiments were made on the submarine cable, it was found that the selenium had all the resistance required. Some of the little bars, an inch or two in length, measured as much as 1,400 megohms, a resistance equivalent to that of a telegraph wire long enough to reach from the earth to the sun, but it was found to be extremely variable. In seeking for the cause of this variability, the discovery was made that the resistance varied with the amount of light falling on the selenium. It is not my object to take up your time to-night by describing the interesting researches that followed on this discovery by Mr. Willoughby Smith. You must all be familiar with the researches of Draper, Marsh, Sale, Adams, Sabine, and Siemens. I shall merely direct your attention to one or two forms of selenium apparatus devised by Dr. Werner Siemens. In the first diagram, you will see what is known in America as Siemens's grating, in which the resistance is sought to be reduced by having two platinum wires arranged in a zigzag form. The whole is covered with selenium, and the current, in passing from one wire to another, has to pass through the selenium. On account of the length of the two wires, the resistance is very greatly reduced. The other form of apparatus is that which is popularly known as Siemens's spiral, in which these two wires, instead of being arranged in a zigzag form, are coiled together so as to form a double spiral, on which is placed a strip of melted selenium. The whole is arranged between two mica plates and pressed together, being afterwards annealed, to produce crystallisation. I am glad that we have here to-night some of the ingenious apparatus devised by Dr. Werner Siemens, and I am also glad that we have upon the platform to-night, Dr. C. W. Siemens, and I hope he will explain to you, and exhibit in operation, the ingenious "selenium eye" that we have upon the platform. In practical experiments with selenium, the enormous resistance is a difficulty; and I shall show you a few forms of selenium cells, devised by Mr. Sumner Tainter, of Washington, and myself. We have been working on this subject for many months past, and have produced selenium cells of such a low resistance, as to be of practical use in experimental work—such low resistance, that we can use them in telephones and galvanometers of ordinary construction. The resistance of selenium cells hitherto employed, have generally been measured in millions of ohms; the lowest resistance I know of has been 250,000 ohms in the dark, but in the form of selenium cells, as shown on the screen, the resistance is only 300 ohms in the dark, and 150 ohms in the light. I will briefly describe the arrangement. If you look at the illustration at the top of the screen, you will see that it represents two brass plates, separated by mica. The upper plate is perforated, and the lower plate has metallic pins attached, which pass through the upper plate, so that their tops are flush with the upper surface of the plate, but do not touch it. You must understand that there are annular cracks round each pin on the upper surface. You will see a plan view of the arrangement in the centre of the diagram. The central circle represents the end of one of the pins, and the larger circle the end of the orifices in the upper plate. The annular cracks are filled with selenium. There is one point to which I will draw your attention, and that is, the conical shape of the perforations in the upper plate. On account of that arrangement, the points of closest approximation between the pins and the plate are upon the upper surface. Now, as the action of light upon selenium seems to be a surface action, this is a special advantage, as throwing the whole current along the surface of the selenium.

The method of annealing selenium which is usually employed is to place the selenium cell in a cylindrical pot with a thermometer, connecting it with a galvanometer and a battery. It is placed inside a pot filled with linseed oil, and the whole is heated over a gas-stove. The temperature rises to about 210° C., and it is retained at 210° C. for many hours—generally about 24 hours in our experiments—and then the whole arrangement—pots and selenium cells—is packed in a box arranged to retard radiation of heat, so that it takes 40 to 60 hours to be cooled down to the temperature of the air. When the selenium

is removed, it is found to be a conductor, and very sensitive to light.

In the experiments of Mr. Tainter and myself, we have devised very many different forms of selenium cells, but it would not do to take up your time by entering too much into the *minutiæ* of this. I shall simply direct your attention to the form of the cell that I am using in my experiments at the present time, a specimen of which is before you now. The selenium cell is cylindrical in shape; in fact, it looks somewhat like a reel of cotton. It consists of numerous brass discs, separated by discs of mica, slightly smaller in diameter than the brass discs. You will understand that when these discs are arranged alternately, you have a large number of annular grooves between the adjoining brass discs and over the edge of the mica; these are filled with selenium, and we have, in this form of cell, about 100 of these selenium rings. By an arrangement, which it is unnecessary to describe to-night, alternate brass discs, Nos. 1, 3, 5, 7, and so on, are metallically connected together, and all the even numbers are connected together, the odd numbers being connected to one pole of the battery, and the even numbers to the other; then the only means for the current to pass is through the selenium rings, and on account of the large number of the rings the resistance of this cell is very small. We prefer the cylindrical shape, because the apparatus can be placed in the focus of a parabolic reflector, and a beam of light coming from a great distance, may be caught by the reflector and brought on to the selenium surface of the cylindrical cell. In selenium cells of the description I have shown you, the resistance is extremely small. An improvement has been made in the method of annealing also. Hitherto the preparation of sensitive selenium has required very many hours, but we can now prepare it in a very few minutes. A cylindrical selenium cell, like that I hold in my hand, is placed in a lathe, and is kept rotating over a gas flame, the cell being protected from the direct action of the flame by a sheet of metal. When the brass is hot enough to melt a stick of selenium applied to the surface, it is rubbed over it, so that we have a uniform surface of selenium. The arrangement is then allowed to cool, but the selenium obtained in this way is a non-conductor, or has a very high resistance. In order to reduce the resistance, and give it sensitiveness to light, we re-heat the selenium over a gas-stove. In the original, amorphous, non-conducting condition, it is black, and shines by reflected light, but as you heat it a remarkable change in its appearance takes place. It crystalises during the heating process, and becomes like frosted silver or lead, or, at all events, it looks like metal. Now, if you continue the heating process at a certain temperature — say 270° C. — this crystalline selenium melts; the moment we observe the first signs of melting, the gas is immediately turned out. No special precaution is taken with regard to cooling the selenium, but it is found on cooling to be a conductor, and to be sensitive to light. Cells of this description have generally a resistance of about 300 ohms, and a sensitiveness of about one-half; that is, the resistance is reduced to-half when it is exposed to a bright light. Prof. Adams has shown that the resistance of selenium is reduced in some proportion to the intensity of the light that falls upon it. One result of his researches was to suggest to my mind, that by varying the intensity of the light falling upon selenium, and observing its conductivity, not with the galvanometer, but with the telephone, we might be able to produce sounds from the telephone. The laws of audibility of the telephone is precisely analogous to the law of electric induction. No sound is produced, so long as you pass a continuous and steady current of electricity through the telephone; it is only at the moment of change from a stronger to a weaker condition, or *vice versâ*, that any audible effect is produced; and the amount of sound is precisely proportionate to the amount of variation in the current. Hence, when a beam of light is allowed to fall on a piece of selenium which is connected with a telephone and galvanic battery, no effect is produced, so long as the beam shines steadily and continuously, but the moment you vary its intensity from a stronger to a weaker condition, or *vice versâ*, you vary the resistance of the selenium; in like manner you vary the strength of the electric current traversing the current; in like manner you vary the power of the magnet in the telephone, the plate of the telephone is attracted or released, and the sound is produced from the plate of iron. If, then, we can vary the intensity of the beam of light in such a manner as to produce variations in the strength of the electric current traversing the telephone, corresponding to the variations in the air produced during the utterance of any vocal or other sound, we shall have produced from that telephone a reproduction of the original sound.

In carrying this idea into execution, it is of course necessary to devise an apparatus by means of which the intensity of a beam of light may be controlled by the voice. Mr. Sumner Tainter and I have devised a large number of forms of apparatus for producing this effect, but I shall only occupy your attention to-night by showing you two of the most successful forms that have been constructed.

In the form of articulating photophone now shown, we have a perforated screen attached to a diaphragm which can be actuated by the voice of a speaker. There are two similarly perforated screens, one behind the other. In the normal condition of the apparatus, the slits in the one screen are almost superposed upon the slits of the other, so that there are slight apertures through which light can be passed, but it will be understood that upon passing bright light through the double screen, and speaking into the apparatus, the movable screen is caused to slide backwards and forwards by the vibration of the diaphragm, thus partially closing and opening the minute orifices for the passage of light. Thus the vibration of the screen, under the action of the voice, controls the amount of light that is passed through. In arranging the apparatus for the purpose of transmitting speech to a distance, a parallel beam of light is employed, so that as little dispersion as possible takes place. You can see on the screen the fixed grating and the movable grating attached to the diaphragm. The light is passed through the double grating, and at some distant point is condensed by means of a lense on a selenium cell,

which is connected with a galvanic battery and telephone. Now the action of the apparatus will be understood. When a person speaks into the tube, more or less light is allowed to pass through, in accordance with the vibration of the plate. You then have a varying beam of light; the amount of light that reaches the distant station varies in proportion to the motion of the plate; that is, in proportion to the motion of the particles of air that actuate the plate; that is, in proportion to the vibration of the voice; the electric resistance of the selenium being affected proportionately to the intensity of the light falling upon it. Thus we have in the telephonic circuit a constantly varying current of electricity produced, the variations of which correspond to the variations of resistance in the selenium — correspond to the variations in the amount of light transmitted by the double grating—correspond to the variations of the speaker's voice—and we know the result; the articulations of a distant speaker are reproduced by the telephone at the listener's ear, although no conducting wire is found between the transmitter and the receiver. I may say, that in this form of apparatus, Mr. Tainter and I have succeeded in carrying on a conversation when the transmitter and the receiver were separated by a distance of about 280 feet. But a very curious effect of articulation was produced. The articulation reminded me of the early forms of telephone, which were shown to the world in the spring of 1876. In a paper read before the American Academy of Arts and Sciences, in May, 1876, I analysed the pronunciation of the telephone as then constructed, and found that, while the vowels were very accurately reproduced, the consonants were very imperfect. It was the same with this form of photophone, and I will give you an illustration of this peculiarity. The transmitted instrument was placed at the open window of my laboratory in Washington, with a selenium receiver a few feet away, and the telephones connected with the selenium receiver were placed in the basement of the same building, out of earshot. A friend then spoke to the transmitter. I, listening at the telephone in the basement, heard the tones of the voice very distinctly, with a great deal of the articulation; familiar sentences, such as "How do you do?" "Do you hear what I say?" "One, two, three, four, five," and such common phrases as these, were easily understood; but, on asking any friend to repeat sentences of the nature of which I could have no previous idea, I was unable to understand the articulation. On coming upstairs I repeated, as nearly as possible, the sounds that I had heard; that is, I gave utterance to a string of gibberish; but, upon comparing this gibberish with the actual sentence that had been uttered, I found that the vowels in the gibberish were identical with the vowels in the sentence. I then asked my friend to repeat another sentence that I could not guess, and the result was rather amusing, and illustrates this same peculiarity of the articulation. Upon going downstairs, and placing the telephone to my ear, I could hear the sentence, "A good piece of bread; a good piece of bread; a good piece of bread." I listened for about twelve or fourteen times, and this sentence was repeated, and the articulation seemed perfect. I then went upstairs, and said to my friend, "I understood it this time; you said 'a good piece of bread.'" He said; "No; I said—'put me to bed.'" It will be observed that the vowels in these two sentences are the same; the consonants alone were defective. I may say, in passing, that our neighbours on the opposite side of the street, seemed very much astonished at the sight of a young man at an open window, shouting, in broad daylight, "put me to bed."

I shall now have the pleasure of showing you the form of apparatus in which the defects of the articulation have been remedied. We now simply speak against the back of a looking-glass that is made of very thin and flexible material. We use microscope glass, silvered by the ordinary process for silvering specula for the telescope. I am holding one of these in a beam of light, so that you may see the reflection produced by the disc. Upon speaking to this disc, it is thrown into vibration and moved backwards and forwards, becoming alternately convex and concave; and you will observe on the screen the effect produced by simply breathing upon it; the beam of light is alternately condensed and scattered; and the intensity of the light falling on the screen is constantly varying under the vibration, of the plate. I can speak to this, but of course the vibrations are too rapid to be followed by the eye. I shall make a trilled *r*, and I think in this case you will be able to observe the vibrations of the disc. [Mr. Bell here showed the vibration of the mirror under the sound of *rrr*, and also the effect produced by articulating the numerals from 1 to 20.]

You will now understand what I have ventured to term an undulatory beam of light, for want of a better expression. By an undulatory beam of light, I mean light that shines continuously on a sensitive receiver, but the intensity of which upon that receiver is constantly varying, in a manner corresponding to the vibration of some sound. The form of apparatus you have seen shown in section in the last illustration. The speaker's voice is directed against the silvered diaphragm through a speaking-tube; the portion of light striking the diaphragm is reflected as a parallel beam, but, on speaking to the diaphragm, it becomes alternately convex and concave, scattering and condensing the light, and making it what I call an undulatory beam. On arranging the apparatus for the purpose of transmitting speech to a distance, Mr. Tainter and I have found the following arrangement advisable. The actual apparatus by which the result is achieved is shown on the table. A beam of sunlight, or a parallel beam of light from any source, is reflected from a plane mirror through an achromatic lens, and brought to a focus upon or near the diaphragm mirror. After being reflected, the rays are again brought parallel, as nearly as possible, by a second lens, and at a distant station the light is received in a parabolic reflector, in the centre of which is the selenium receiver. It is found in actual practice, in utilising sunlight for this purpose, we are very apt to crack our glass, on account of the great heat at the focal point, and yet we want great concentration of light in order to allow for some loss, because we must have some loss in transmitting to a great distance, so we place the focal point not on the mirror, but near it, and place in the path of the beam a concen-

trated solution of alum, for the purpose of absorbing the heat rays of low refrangibility, to protect the mirror as much as possible. You will understand that telephones are connected with the selenium receiver and a battery. You will also understand that when a person speaks to this mirror, the intensity of the beam of light is constantly changed, the electric resistance of the selenium is constantly changed, and the sound that is taken into the transmitter is reproduced by the telephone in circuit with the selenium.

In experimenting with this apparatus, we have been unable to attempt the reproduction of speech at a great distance on account of the necessary privacy of our experiments; but we have succeeded admirably at the greatest distance we have tried. I may give you an account of the first experiment that was made at a great distance. The transmitting instrument, similar in construction to the apparatus here shown, was placed on the top of the Franklin School-house, in Washington, and the selenium receiver inside a parabolic reflector—the identical receiver that we have here to-night—was placed in the window of my laboratory in L-street in the same city, the distance between the two being a little over 800 feet. It was impossible to communicate by word of mouth across that distance; and, while I was observing Mr. Tainter on the top of the school-house, almost blinded by the light that was coming in at the window of my laboratory, and vainly trying to understand the gestures he was making to me at that great distance, the thought occurred to me of listening to the telephone connected with the selenium receiver. Mr. Tainter saw me disappear from the window, and at once spoke to the transmitter. I heard distinctly what he said:—"Mr. Bell, if you hear what I say, come to the window and wave your hat." It is needless to say with what gusto I did wave my hat.

It is almost always the case that when we follow up one path of investigation, another opens upon our attention, and in the course of reducing to practice the idea of the photophone, as described to you to-night, Mr. Tainter and I have been led to a discovery of the greatest possible interest to the scientific world. Of course we all know that the molecular vibration, or disturbance in a rod of iron by the magnetising influence of an intermittent magnetic current can be heard as sound by placing the ear in direct contact with the rod of iron, and it occurred to us that a molecular disturbance of any kind, and however produced, if rendered intermittent, should in like manner be observed as sound by placing the ear in close contact with the substance. Now we know in the case of crystalline selenium that a molecular disturbance is produced by light. It is usually manifested to our senses through the medium of an electric current; but, if this theory were correct, this molecular disturbance should be developed as sound by placing the selenium in close contact with the ear, and rendering a beam of light intermittent. The form of apparatus for experiments on the question is on the table before me, and it may be well to show you on the screen the mode of using it. The light is rendered intermittent by being passed through one of the orifices in a perforated wheel, and as the actual apparatus is on the platform, it will not be necessary to enter into any detailed description of it. I shall briefly show you the arrangement of the whole in a sectional view. A beam of sunlight is brought to a focus by means of a lens. The diameter of the surfaces in the perforated disc, is just the diameter of the image of the sun formed in the focus of the lens, so that all the light impinging on this lens passes through the minute orifices of the wheel. The divergent beam is then again rendered parallel, so that it may be transmitted to the distant station, and is there converged on a piece of selenium in circuit with the telephone. You will understand that the rotation of this wheel will render the beam of light, falling upon the selenium, intermittent, and if the beam is interrupted a sufficient number of times per second, a musical note is perceived in the telephone. Now, our idea was that we should hear that musical note without the aid of the electric current or telephone, by placing the ear in close contact with the selenium itself. We made many experiments with different pieces of selenium, and even with other substances, to see whether this effect was produced, but the results were entirely negative. A very curious observation, however, was made in the course of the experiments. It was our custom to interrupt the musical tone by placing the hand in the path of the ray. The moment the shadow of the hand fell on the selenium, the sound immediately ceased, and the moment the hand was taken out of the path of the beam, the sound came again. In the course of our experiments, we were led to substitute, instead of the hand, a thin sheet of hard rubber, which happened to be in the workshop. At the end of the diagram, you will see the selenium receiver and the hard rubber—an apparently opaque sheet of hard rubber or ebonite—placed in the path of the beam. Now, the discovery to which I direct your attention first, is the fact that the interposition of this opaque substance does not entirely cut off the sound; that something passes through the hard rubber that affects the electric resistance of the selenium, and produces a sound. The effect is still more remarkable when, in place of holding the india-rubber near the selenium itself, it is held on the other side of the rotating disc, so that no light reaches the rotating disc. An invisible beam is brought to a focus, is rendered parallel by a second lens, and is again brought to a focus by another lens, and a musical note is developed at the telephone. I do not pretend to say what the nature of these rays is, but it is difficult to believe that they can be heat rays, for, in the first place, hard rubber is a substance which becomes heated when exposed to the sun's rays, and does not, therefore, transmit heat rays to any appreciable extent. But, if we place in the path of the beam, two sheets of hard rubber, and between them a glass vessel containing a saturated solution of alum, the effect is still obtained. I do not pretend to say what the cause of this strange effect may be. I have already told you of our attempt to hear molecular disturbance in selenium directly, without the aid of an electric current, but it occurred to us on observing the anomalous behaviour of the hard rubber sheet, to place it to our ears in place of the selenium that we had been experimenting with. The arrangement is shown on the next diagram.

I placed the sheet of hard rubber in close contact with my ear, while an intermittent beam of light was allowed to fall on the hard rubber, and a clear distinct musical note was the result, the pitch of which depended on the rotation of the wheel. That it was not in any way due to any acoustical vibration in the air, was proved by simply interposing the hand in the path of the beam. This would not have sufficed to prevent the audibility of aerial vibration, but it at once stopped the sound in the hard rubber. On using a sheet of hard rubber as a diaphragm, and listening to it, as shown in the next illustration, the loudness of sound was very much intensified. It then occurred to Mr. Tainter and myself that it might be necessary, in order to hear the molecular disturbance produced by light, that the substance should be in the state of a thin diaphragm, so we made a thin diaphragm of selenium, and the same effect was observed. A musical note was produced from the selenium directly, but the sound was not to be compared to that produced by the hard rubber; it was very much inferior in volume. But the curious fact comes out that all substances in the shape of a thin diaphragm emit sound when exposed to an intermittent beam of light. I have on the platform the various diaphragms with which we have experimented; all the metals, even paper, mica, glass, carbon, and all sorts of substances, in the shape of thin diaphragms, emit musical tones under the action of the intermittent beam. One other interesting feature is the difference in the intensity of the sounds produced by different substances, and this is a most interesting field of exploration for the scientific man. It occurred to us, as an explanation of the reason why it was necessary to use thin diaphragms for the different substances, instead of masses, was, that the molecular disturbance produced by light was chiefly on the surface, and the vibration had, therefore, to be transmitted through the mass of the substance in order to produce the effect. We thought, therefore, that if we could listen at the illuminated side of the diaphragm, we should hear the sound with greater distinctness. It is rather difficult to arrange apparatus suitable for this experiment; but the following form occurred to us. Instead of using a substance in the shape of a thin diaphragm, we used it in the shape of a tube. We first of all experimented with an ordinary rubber tube. The light was brought to a focus just at the mouth of the tube, so that the beam diverging from the focal point, struck the interior sides of the tube. We listened at the other end of the tube, and, of course, our ears were then in communication with the illuminated side. A distinct musical tone was heard, and every substance we have tried, in the shape of a tube, has emitted musical tones in this way. We can even hear sound when, in place of an artificial tube, we focussed the light into the interior of the ear itself.

Another form of this experiment has occurred to me since my arrival in Europe; and the sun, very fortunately, coming out for a few hours, while I was in Paris, I was enabled to put it into execution with success. If we take a transparent vessel, such as a test-tube, we can place inside it substances in any physical condition—n the solid liquid or gaseous state—and by connecting the open mouth of the test-tube with a hearing-tube, we can listen while we throw an intermittent beam of light on the substance through the transparent glass of the test-tube. All the substances that I was able to try in the short time at my disposal yielded musical notes, with the exception of water and chlorate of potash in the state of powder. Crystallised sulphate of copper gave a very beautiful note. A whole cigar placed in the test-tube also emitted quite a loud note; but the best sound I think was produced by some little chips of pine wood dropped into the tube. It is not necessary that the substances should be solid or liquid; it is sufficient to fill the test-tube with tobacco smoke, and the musical note is produced, whereas without the tobacco smoke no sound, or a very slight sound, is developed. I have been able to repeat these experiments, within the last few days, at the Royal Institution, with the aid of your artificial sun (for we cannot hope to have the natural sun in London in November or December), the electric light. Professor Tyndall suggested a modification of the experiment that has also proved successful—to fill this tube with an absorbent gas. We placed a few drops of sulphuric ether at the bottom of the test-tube, and then submitted the perfectly transparent test-tube to the action of the intermittent beam of light. A distinctly audible, but feeble, musical tone was the result, and this is very suggestive and very significant, as it seems to prove that the action is strictly a molecular action, and that we can hear even in a gas the result of a molecular vibration. I have taken up a great deal of time, and I must thank you very much for the way in which you have listened to me to-night. I only wish that I could show you instruments in operation, but the effects produced, though perfectly demonstrable, are too feeble to be satisfactory to an audience like this. We require great quietness and a good light. If we only had the sunlight here, I should have no hesitation in making the experiments, but as it is, we are obliged to confine our experiments to a few scientific men, working at such a laboratory as that of the Royal Institution.

DISCUSSION.

The Chairman having invited Dr. Siemens to explain his "Selenium Eye,"

Dr. Siemens, F.R.S., said he had listened with intense interest to the discourse which Professor Graham Bell had given. The world had been astonished before with his invention of the telephone, and now he came forward with an instrument equally marvellous in its results. The property of selenium to alter its electrical resistance under the influence of light, was, as had been stated first brought before the world by Mr. Willoughby Smith, and so remarkable was this discovery that many physicists turned their attention to the subject. His brother, Dr. Werner Siemens, took up the inquiry with a view of determining the cause of this extraordinary variation in resistance caused by light, and the conclusion to which his researches, which were communicated to the Berlin Academy, led him, was that the resistance of selenium, and probably, indeed, of all substances, varied inversely to the amount of heat which they contained; and the reason why selenium showed such extraordinary changes under the influence of light was, that under that influence, it changed from one aggregate condition to another—from an amorphous to a crystal-

line condition; and that at the moment when this change took place, a great deal of heat was absorbed, and therefore the specific heat of the selenium was very much increased. This was strictly a molecular change, and bore on the further discovery which Professor Graham Bell had made, that he could hear the changes going on even in gaseous bodies, produced by the passage of light. The little instrument which he (Dr. Siemens) had constructed to show the members of the Royal Institution was on the table. It had the form of an eye, and on opening the lids, a lens was presented to the light; through that lens, the light, falling upon it, was concentrated upon a spot in the interior of the ball. At that spot one of the selenium gratings, which had been described, was placed, a grating not larger than a threepenny piece, consisting of five wires laid in zigzag fashion; one wire was connected to the positive, and the other to the negative pole of a battery. These wires, lying close together, but not touching, were laid on a plate of mica; a drop of selenium was placed upon them, and this small quantity sufficed to produce the desired results. The principal object he had in devising it was to construct a selenium photometer; but a difficulty arose in using it for that purpose, because selenium got fatigued under the influence of light. The eye, after being exposed for any considerable period to an intense light, became insensitive, and the lids had to be closed; it had to go to sleep for some time before it regained its sensitiveness, and the analogy to the human eye went even further than that. If the eye were used after having been kept in the dark for a length of time, it would detect the slightest gleam of light, and mark it on the galvanometer, whereas after it had been once used in intenser lights, a small gleam would be utterly lost upon it, until it had again had ample rest. The instrument before them had not been used for some years, and it might still be active, but the audience would have to take the Chairman's word for it, since the galvanometer in circuit with the "eye" was not one whose indications were visible to a number of persons at once. [Dr. Siemens then experimented with variously-coloured sheets of cardboard prepared for the purpose, and the reflected light was found to cause a deflection of the galvanometer in each case, the slightest effect being produced with light reflected from a black piece of paper, and successively increasing with green, red, and white, the greatest of all being produced by exposing it to the direct light of an argand burner.] These experiments showed the great sensitiveness of selenium; but Professor Bell had gone much further, and had prepared an instrument with concentric plates of selenium and intervening plates of mica, and operating upon a much larger surface. He had gone much further than had been done previously. Then came the further step which he had so boldly taken, of making light become the carrier of speech. As he had justly said, this seemed marvellous at first, but when you knew how to do it, it became simple, like everything else, and he (Dr. Siemens) must congratulate the Society on having had the method of doing it so clearly explained.

Mr. W. H. Preece referred to the high honour which Professor Graham Bell had done him in asking him to bring before the English public his great invention of the photophone, and said he had willingly undertaken the task, but had had to give it up in consequence of another event with which Professor Bell was indirectly connected. It was an immense relief to him to find that just as he had written to the secretary to say that he could not read a paper, Professor Bell himself telegraphed to say that he was coming, and the consequence was they had had one of the pleasantest evenings he had ever spent in that room. It was not only the beauty of the discoveries, and the clear manner in which they had been described, which he admired, but the truly scientific way in which they were followed up, and the way in which the matter had grown in the hands of Professor Bell and Mr. Tainter, until it burst out like a flower in full bloom. And there was another interesting point in connection with this instrument, and that was that, following the excellent example of Professor Hughes, Mr. Bell had thrown this investigation open to the public, unrestricted by any patent. They had heard a great deal, at different times, of the efforts poets made to try and extract ideas from nature; one had talked about bringing down lightnings from heaven, another spoke of bringing "spirits from the vasty deep," and another spoke of "the music of the spheres;" but, to-night they had seen how a patient, plodding philosopher could go to the other extreme, and make those little molecules which the eye could not see, and the mind scarcely grasp, imitate the beautiful modulations of the human voice. Professor Bell had caused a great deal of trouble to practical men, especially to telegraph engineers, by forcing them to deviate, to some extent, from their own sphere, and study the science of sound, but now he had compelled them also to go into the study of light; but they were indebted to him, not only because he had added to their practical apparatus a useful appliance, but because of the interesting and singularly beautiful nature of his discoveries.

Professor Hughes, F.R.S., being next called upon by the Chairman, merely expressed his admiration of the apparatus.

The Chairman said it only remained for him to discharge a work of supererogation by proposing a vote of thanks to the lecturer. They had had the matter put before them by Mr. Preece, in language more worthy of a poet than of a chief telegraph engineer, and in a way they would always remember. He could not pretend to emulate that style, nor to speak adequately on the subject of the evening, but the audience might consider for a moment what they had had brought before them—the intimate connection of those things which used to be considered three separate subjects of study, and three distinct sciences—electricity, light, and acoustics. Professor Bell had shown them that the three had so intimate a connection that it was perfectly possible, where there was adequate light, and the means of transmitting it from place to place, not indeed to make that light the conveyor of sound, but to make it reproduce, at a distance, the sound which in the outset caused the light to vary in its intensity. It was a matter which, if the present generation were capable of surprise at any scientific discovery, would certainly surprise them. Would not the proposition have been said to emanate only from one worthy of a distinguished position in a lunatic asylum—the proposition, "I desire to convey sound to a distance; I have no means of doing it excepting by a ray of light." It would have been said at once, "You cannot do it; that is not a means; it is incredible and impossible;" and it might have been so said even after Professor Bell's wonderful discovery of the telephone. When they first heard of that, it struck them as one of those wild suggestions which occasionally were made, and came to nothing. Only about a year ago they saw in the public prints that some person in Australia had discovered a means of sending human beings and animals to sleep for any length of time required, and they were told they were to get fresh meat from Australia, by sending animals over in a somnolent state, to be woke up to be killed. They all laughed at that, because it did not turn out to be true; but it might have been true, and if it had been, it did not seem to him so wonderful as the statement:—"I wish to repeat a sound that has been heard in London, in a village 10 miles off. I have no means of doing it, except the sun's rays, and I will do it with that." Nobody making that statement would have been entitled to belief, but yet Professor Bell had brought it into the range of an accomplished fact. Unhappily, it was one of those delicate experiments which could

only be shown before a chosen few, and in places well adapted for the purpose. The great advantage of having a subject of this kind taken up by a man of Professor Bell's calibre of intellect, was this—that as he went on experimenting, new circumstances arose, and he had brought forward that evening such a list of suggestions for extended inquiry in physics, as would occupy the scientific men of Europe for many years to come. In conclusion, he (the Chairman) hoped that, as many had been unable to attend the lecture that evening, Prof. Bell, if he could not repeat the lecture, as he did that on the telephone on a former occasion, would obtain a promise from Mr. Preece to do it for him.

The vote of thanks having been passed unanimously,

Professor Graham Bell, in thanking the meeting, said he wished it were in his power to accede personally to the Chairman's request, but engagements on the other side of the Atlantic would make this his last lecture on this subject in Europe. He would, however, do his best, with great pleasure, to prevail on Mr. Preece to fulfil the request which had been made.

"DESCHUGARA," A NEW CEREAL AND FORAGE PLANT.

A new forage plant is announced from Central Asia, under the name of "Deschugara." It is said to be largely cultivated in Turkestan, as well as in Poland, where it has given most satisfactory results. From 100 lbs. of seeds sown, 2,800 lbs. of grain have been harvested, and a large quantity of straw, which is consumed with avidity by cattle and sheep. The plant has a tall-growing, stout stem, which forms a green cattle food. A variety of the plant ripens three months after being sown. In the climate of Odessa it is described as arriving at maturity as soon as it does in its own country. The chemical composition of the plant approaches very nearly to that of the oat and barley, so that it is extremely useful as a cattle food. The seeds, however, reduced to powder, are used as ordinary flour. Some mystery attended the botanical identification of this plant, when its properties were first made known in the pages of a continental journal some few weeks since. Mr. Christy has, however, succeeded in obtaining some seed from Russia which, together with information he has also obtained, prove the plant to be that of *Sorghum cernuum*, a grass closely allied to the well-known Dhurra of India.

CORRESPONDENCE.

PEPPERMINT TEST FOR DRAINS.

It seems to me that the Boston plan of using oil of peppermint (described in the *Journal* of November 19), is rather clumsy, inasmuch as the small quantity of oil used might stick in some crevice and not be washed out by the two pails full of water, by which it is followed. I prefer to shake up the oil thoroughly with water in the largest available bottle, before pouring it down. It does not dissolve in the water, nor does it really mix with it, but it forms a strong-smelling emulsion, which answers the purpose just as well as a true solution in alcohol would. It would be interesting to know what quantity of the oil the small bottles contain, which are to be bought in Boston at two dollars the dozen, or about eightpence each, and whether the quality is at all equal to English Mitcham oil. Our practice at present to use an ounce of the Mitcham oil for each house that we test, and that costs 2s. 6d. We have tried the foreign oil, which can be bought at about half the price, but we find that it is only half as strong, or in other words makes only half the quantity of emulsion, so that there is no economy in using it. What we want is that some manufacturer would make an oil as strong smelling as the Mitcham oil, but not so highly refined, and which could be sold cheaper. As the demand increases we have no doubt that this will be done. Our experience is the same as that of the Boston people as to the necessity for the person who pours the oil down not mixing among those who are trying to detect any escape of it from drains or pipes, as he brings an amount of the vapour adhering to his clothes, which makes accurate observation of leaks impossible.

Ether, which we formerly used, was not so bad in that respect, but it was too expensive, and also rather dangerous, so we always use oil of peppermint now.

Cosmo Innes.

7, John-street, Adelphi.

"HAYDON'S PICTURES TO THE COAL-HOLE!"

Although such were the words recited to me by Sir Martin Archer Shee, it is but justice to Haydon to say that he denied them. It so happens that I am, by chance, reminded of this. In 1842, I reviewed Haydon's lectures on "Fresco," in the "Civil Engineer and Architects' Journal" for 1842, vol. v., and introduced the coal-hole anecdote. At p. 201 is a characteristic letter by Haydon in reply to the review, and denying the anecdote. At p. 388 is another curious contribution on Wilkie, and at p. 413, one on schools of design by Haydon.

Hyde Clarke.

32, St. George's-square, S.W.,
29th November, 1880.

OBITUARY.

G. W. Yapp.—By the death of Mr. G. W. Yapp, on the 15th November, at the age of 69, the Society loses a frequent correspondent to the *Journal*. Mr. Yapp, born in London, was the son of a naval officer belonging to an old Herefordshire family. He was connected by family ties, among others, with Sir Walter Scott, Dickens, and Douglas Jerrold. In early life he was trained in the secretariat of Joseph Hume, but he entered too late to benefit materially by that economist's patronage. He commenced his literary work in 1837, as a writer for the "Penny Cyclopœdia." He proposed a plan for the formation of the Parliamentary library at the Reform Club, and assisted materially in carrying it into execution. In 1851, Mr. Yapp compiled the catalogue of the Great Exhibition of 1851. He was for a long time an agent in London and Paris for a patent firm at Washington. His exhibition connexion took him to Paris, where he was in 1855, and he there compiled "Duties on Imports into France." He had collected the materials for a technological dictionary, French and English, which was never published. In 1858 and 1859 he was Paris correspondent of the *Daily Telegraph*. He prepared the English translation of the Official Catalogue in 1867, and which was presented to the Emperor some hours before the French edition. He unfortunately staid in Paris during the siege, and suffered its terrible vicissitudes, losing there one of his children, and laying the foundation of mortal illness for himself and another child. His account of the siege appears in the "History of the Franco-German War" Mackenzie, Glasgow).

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock. For meetings previous to Christmas:—

December 8.—"London Fogs." By Dr. Alfred Carpenter. Edwin Chadwick, C.B., Vice-President of the Society, will preside.

December 15.—"The Use of Sound for Signals." By E. Price Edwards, Secretary to the Deputy-Master of the Trinity-house. Dr. Tyndall, F.R.S., will preside.

For Meetings after Christmas:—

"Buying and Selling; its Nature and its Tools." By Prof. Bonamy Price. On this evening Lord Alfred S. Churchill will preside.

"Causes of Success and Failure in Modern Gold Mining." By A. G. Lock.

"The Participation of Labour in the Profits of Enterprise." By Sedley Taylor, M.A., late Fellow of Trinity College, Cambridge.

"The Gold Fields of India." By Hyde Clarke.

"Flashing Signals for Lighthouses," By Sir Wm. Thomson, F.R.S.

"The Present Condition of the Art of Wood-carving in England." By J. Hungerford Pollen.

"Five Years' Experience of the Working of the Trade Marks' Registration Acts." By Edmund Johnson.

"Trade Prospects." By Stephen Bourne.

"The Manufacture of Aërated Waters." By T. P. Bruce Warren.

"The Compound Air Engine." By Col. F. Beaumont, R.E.

"Improvements in the Treatment of Esparto for the Manufacture of Paper." By William Arnot, F.C.S.

"Deep Sea Investigation, and the Apparatus used in it." By J. G. Buchanan, F.R.S.E., F.C.S.

"The Discrimination and Artistic Use of Precious Stones." By Prof. A. H. Church, F.C.S.

"Forest Conservancy in India." By Sir Richard Temple, Bart., K.C.S.I.

"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

"Indian Agriculture." By W. R. Robertson.

"Trade Relations between Great Britain and her Dependencies." By Wm. Westgarth.

"The Languages of South Africa." By R. Cust.

"The Loo Choo Islands." By Consul John A. Gubbins.

Cantor Lectures.

Monday Evenings, at eight o'clock. The First Course, on "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." Five Lectures, by Prof. A. H. Church, M.A. Oxon., F.C.S.

Lecture III.—December 6.

Stoneware and other wares glazed with salt.

Lecture IV.—December 13.

Soft paste porcelains, European and Oriental.

Lecture V.—December 20.

Hard paste porcelains, Chinese, Japanese, and European.

The Second Course will be on "Watchmaking," by Edward Rigg, M.A. Three Lectures.

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Three Lectures.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

Admission to Meetings.

Members have the right of attending all the Society's meetings and lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 6th ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. A. H. Church, "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." (Lecture III.)
Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Annual General Meeting. Mr. Clare Sewell Read, "America and its Farming."
Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. Frank W. Grierson, "The National Value of Cheap Patents."
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Leslie Stephen, "The Relation of Morality to Literature."

Tuesday, Dec. 7th...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Theophilus Seyrig, "The Different Modes of Erecting Iron Bridges."
British Horological Institute, Northampton-square, E.C., 8 p.m. Mr. Edward Rigg, "Friction."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Biblical Archæology, 9, Conduit-street, W., 8½ p.m.

Wednesday, Dec. 8th...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. Alfred Carpenter, "London Fogs."
Geological, Burlington-house, W., 8 p.m.
Microscopical, King's College, W.C., 8 p.m. 1. Dr. Hudson, "*Floscularia trifolium* n. sp." 2. Mr. C. Stewart, "Some Structural Features of *Echinometridæ*." 3. "Notes on the Movements of Diatoms, the Construction of Object Glasses, Swinging Substages, &c."
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Telegraph Engineers, 25, Great George-street, S.W., 8 p.m. Mr. W. H. Preece, "The Photophone and the Conversion of Radiant Energy into Sound."

Thursday, Dec. 9th...Royal, Burlington-house, W., 4½ p.m. 1. Major Herschel, "A Simplified Form of the Torsion Gravimeters of Broun and Babinet." 2. C. Schröter, "Note on the Microscopic Examination of some Fossil Wood from the Mackenzie River." 3. Dr. Hopkinson, "Electrostatic Capacity of Glass." II. 4. Dr. Urban Pritchard, "The Cochlea of the *Ornithorhyncus platypus* compared with that of Ordinary Mammals and of Birds."
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Dr. Lionel S. Beale, "The Germination and Propogation of Disease."
Inventors' Institute, 4, St. Martin's place, W.C., 8 p.m.
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Prof. Teixeria, "Note sur Dérivation des Déterminants." 2. Mr. W. B. Grove, "The Solution of the Inverse Logical Problem." 3. Mr. T. Craig, "Motion of a Viscous Fluid."

Friday, Dec. 10th...Froebel Society (at the House of the Society of Arts), 6 p.m. Annual Meeting.
Folk Lore Society, 22, Albemarle-street, W., 8 p.m. Mr. John Fenton, "The Birth of a Deity; or the Story of Unkulunka."
Astronomical, Burlington-house, W., 8 p.m.
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.

Saturday, Dec. 11th...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Lieut. L. Darwin, "The Rate of Loss of Light from Phosphorescent Surfaces." 2. Dr. Alder Wright, "The Determination of Chemical Affinity in Terms of Electromotive Force."
Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,464. Vol. XXIX.

FRIDAY, DECEMBER 10, 1880.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

REFORM OF THE PATENT LAWS.

The Council adopted the following Petition to the House of Commons, at their meeting on Monday, 6th inst.:—

To the Right Honourable the Commons in Parliament Assembled.

The Humble Petition of the Council of the Society of Arts, Manufactures, and Commerce, incorporated by Royal Charter,

Sheweth,—

1. That the Society is deeply interested in the Patent-law, and submits that it ought to be made to conduce, as far as possible, to the progress of the Arts, Manufactures, and Commerce of this country, so as to allow the inventions of the United Kingdom to compete fairly with those of all the world.

2. That the Society, in the years 1850, 1851, and 1852, published reports on the Patent-law as then existing, and that those reports were instrumental in inducing Parliament and the Government to pass the Patent-law Amendment Act, 1852, which completely reformed the law.

3. That the effect of such reform has been greatly to stimulate invention, and has so increased the amounts derived from Patent fees, that they have now reached the sum of £180,000 a-year, of which only about £40,000 are expended in connection with the administration of the law, leaving £140,000 as a tax on the progress of invention.

4. That your petitioners are of opinion that the law still retains some antiquated fictions which should be abolished; that it should be greatly simplified; and that, as Patents relate to Arts, Manufactures, and Commerce, all matters connected with them should be administered by persons having knowledge of Arts, Manufactures, and Commerce, and not by legal functionaries, however eminent.

5. That your petitioners desire to call the attention of your Honourable House to the Patent Museum, which is in an unsafe, overcrowded, building, although it contains unique and valuable specimens of those early mechanical inventions which have revolutionised the Arts, Manufactures, and Commerce of the civilised world; that such Museum is quite unworthy of the Nation, and ought to be replaced by a suitable building, containing accommodation for a Reference Library.

Your petitioners, therefore, pray your Honourable House to cause the present Patent-law to be amended, and its administration to be entrusted to the Lords of the Privy Council for Trade.

And your petitioners will ever pray.

Signed on behalf of the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce,

H. Trueman Wood, *Secretary.*

The Council also appointed a Committee to draft a Bill for submission to the Government.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given by Mr. G. J. Romanes, F.R.S., on "Animal Intelligence."

The dates for the lectures will be Wednesday, 29th December, and Wednesday, 5th January.

The lectures will commence at seven o'clock. As in former years, admission will be by ticket only. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and one adult. All members who require tickets should apply at once, as there may be difficulty in accommodating those who postpone their applications until the date fixed for the lecture.

By order,

H. Trueman Wood, *Secretary.*

PRACTICAL EXAMINATIONS IN VOCAL AND INSTRUMENTAL MUSIC.

The next Examination in London will be held at the Society's House during the week commencing 10th of January, 1881.

The Examination will be held at three periods —morning, afternoon, and evening—viz., from 10 to 1, 2 to 5, and 7 to 10 o'clock on each day of Examination. Candidates may select either of these periods, but, the number of candidates in these Examinations being large, no special day or hour can be arranged for. The numbers will therefore be arranged in order of application. The Examination for the Organ and Harmonium will be held in the evening only, and special arrangements will be made according to the number of applications.

The fee is 10s. for the Honours (including both vocal and instrumental Examination), and 5s. for the First or Second Class (vocal or instrumental) Examination. If vocal as well as instrumental music, or two separate instruments, be taken by the same candidate for the First or Second Class Certificate, a fee of 7s. 6d. must be paid.

The Certificates will be prepared as soon as

possible after the Examinations, and can be had upon application at the House of the Society of Arts, on or after 1st March, 1881.

No Certificate will be granted to any candidate for Honours who does not obtain a First Class in the practical portion of the Examination, either vocal or instrumental. Candidates holding one of such Certificates, obtained in a former year, need not again undergo this portion of the Examination, but should bring their Certificate for the Examiner's inspection.

The Examination of each candidate will be private; no one but the Examiner and the accompanyist being present, unless it be a member of the Society of Arts' Committee. No list of candidates will be published.

Particulars will be forwarded on application to the Secretary, Society of Arts, John-street, Adelphi. No names can be received after 24th Dec. 1880.

PROCEEDINGS OF THE SOCIETY.

FOURTH ORDINARY MEETING.

Wednesday, December 8th, 1880; Edwin Chadwick, C.B., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Aird, David Alfred, 2, Sussex-gardens, Hyde-park, W.
Angus, Joseph, The Hermitage, Langly-lane, South Lambeth, S.W.
Biddiford, George Francis, Barnwood-lodge, Gloucester.
Clements, Hugh, 5, Park-terrace, Peckham, S.E.
Foster, Thomas Nelson, Allt Dinas, Bays-hill, Cheltenham.
Morton, Joseph, 39, Cheapside, E.C.
Obach, Dr. E., 17, Charlton-villas, Church-lane, Old Charlton, S.E.
Ridpath, J. Lionel, 12, West Kensington-gardens, W.
Snelgrove, Horatio Richard, The Grove, Clapham-common, S.W.
Sykes, Fred. W., Gosport Mills, Huddersfield.
Traill, James Christie (of Rattar, N.B.), Castle-hill, Thurso, Caithness.
Vogel, Sir Julius, K.C.M.G., 135, Cromwell-road, South Kensington, S.W.
Ward, Frederick Peterson, 46, Hamilton-terrace, St. John's-wood, N.W.
Wright, John Brooks, 96, Buchanan-street, Glasgow.
Young, Charles E., 71, Clapham-road, S.W.
Young, Sir Charles Lawrence, Bart., 5, Ashburn-place, Cromwell-road, S.W.
Young, George, 7, The Terrace, Ryde, Isle of Wight, and 43, Dover-street, Piccadilly, W.

The following candidates were balloted for, and duly elected members of the Society:—

Brenchley, Samuel, Hunt Bridge-house, Matlock.
Gassiot, Charles, Elmwood-house, Upper Tooting.
Gundry, Joseph Pearkes, the Cottage, Bridport, Dorsetshire.
Jaques, Leonard, J.P., 18, Seymour-street, W.
Laxton, Frederick, Brighouse, Yorkshire.
Nix, John H., 77, Lombard-street, E.C.
Noel, Hon. Henry, 17, Westbourne-terrace, W.
Northampton, Marquis of, Castle Ashby, Northampton.
Ormerod, Thomas, Woodfield, Brighouse, Yorkshire.
Robertson. Sir D. Brooke, C.B., Athenæum Club, S.W.
Robertson, J. Murray, Lower Grove-house, Roehampton.
Seymour, Major-General W. H., Travellers' Club, Pall-mall, S.W.
Sheppard, Samuel Gurney, 31, Oxford-square, W.
Simmons, Charles J., 56, Leverton-street, Leighton-road, N.W.
Skaife, John Slade, 32, Milner-square, N.
Slade, Francis William, Eldon-pk., South Norwood, S.E.
Volk, Magnus, 40, Preston-road, Brighton.

The paper read was on—

LONDON FOGS.

By Alfred Carpenter, M.D.

There are fogs and fogs. I am not about to ask you to consider all kinds of those creations. There is the fog which pervades men's brains, and takes from them the power of judging rightly, and separating truth from error. There is a fog which may be aptly called error, ever seeming to present itself for the purpose of blurring the outline of our vision, of interfering with our power of pursuing a right path, and causing us to follow a wrong one. This kind of fog, though fully in my mind, is not the fog with which we have to deal to-night, except it may be as a link connecting our subject with the difficulties which beset its consideration. I do not propose to ask you to inquire into the causes of the regular Scotch mist, which wets you through and through almost before you realise the fact that it is a fog, neither do I propose to touch upon the causes of those fogs which rise from the bosom of the great deep, and are occasionally carried by the wind into all parts of our land. These are not the fogs I ask you to consider. They are white fogs, seldom, if ever, producing a real darkness, except during the dark hours themselves; they do not shut out all evidence of the ruler of the day whilst he is above the horizon, as if he were not. They do not cause the birds of the air to return to their roosts under the impression that Nature has changed her plans. Neither is it with those mists which rise from the bosom of Father Thames, or of any other stream running, either above or under ground. These fogs will present themselves whenever there is a particular kind of change in the meteorological condition of the atmosphere, and when heat, moisture, and pressure are rapidly altered in the necessary direction. These fogs are all beyond the power of man to either increase or decrease, to control or prevent. They are natural events, which will happen in spite of man or of his works, and nothing that he can do will materially alter their incidence. At times they exist everywhere in the lowlands of the British Islands; they must be endured, but their evil effects may be, in a great measure, warded off by simple means based upon common sense. But there are other fogs which are not primeval, which do not exist everywhere, and which are produced by the acts of man himself, and are caused by wasteful works which need not continue in operation.

They are specially peculiar to great aggregations of people, and their densest points are always to the leeward of the masses which have produced them. Their worst effects date from the introduction of coal, which gave power into the hands of men to defy distance, and to bring millions, or a moiety of the million, into the close intercourse of a great city; but they are not to be found in all great cities, for aggregations of peoples, such as at St. Petersburg and Moscow, who do not burn coal in the wasteful way that we do, are not visited with them; neither are they found in the great cities of the East, which, from the natural warmth of their surroundings, do not want fires in a general way. I am not about to assert that the fogs I speak of are entirely caused at all times by fuel smoke. I am not about to assert that coal smoke is alone responsible for all the evils which belong to these fogs, but it is the principal factor which make London and its suburbs intolerable as places of residence for certain constitutions. It does materially add to the mortality of the metropolis, and at times it is the sole cause of conditions which prevent the proper enjoyment of that life which kind Providence intended for us. It is a main factor in the production of a high rate of mortality, arising from the absence of ozone, or of ozonised oxygen, or depreciation of oxygen capable of immediately acting upon changing organic matter. It also causes many of our public buildings to show signs of premature decay, and, day by day, is producing a destruction of property which, if it could be stopped, and its value accurately estimated, would probably be sufficient to repay ten times over the cost of the works which are required to prevent this unnecessary and ruinous loss. It will be asked, how I am able to prove the truth of my proposition. That is the business now before us. I think it has been fully proved of late years, by the numerous fogs which have occurred in the midst of summer, shutting out the light of day, and producing an Egyptian darkness at times when ordinary fogs have not existed. It was fully proved by a fog which occupied the West-end of London the other day, and which caused a mid-day darkness on a September Sunday, which could be felt. That day had not been preceded by any cold weather, the barometer was high, and was rising; the thermometer was high, it was not falling, and the dew point was high. The air was still, there was no perceptible wind; there was, however, an exceedingly slight current, which, as I afterwards found, occupied within a narrow space nearly all the points of the compass. The centre of a circle thus produced was mainly at the West-end of London. Some magnetical changes, the nature of which was not apparent, led to the production of a dense atmosphere at 11.30 a.m., on September 26th, which indirectly caused gas-lights to appear in Buckingham Palace and other parts of Belgravia, obscured the sun at mid-day in as perfect a manner as it was possible to be obscured over a great town by human aid. I say advisedly, by human aid, because a few experiments made upon the spot proved that the darkness was caused by unconsumed carbon in the atmosphere: that the pall thus spread over the place was limited to a moderate elevation, not reaching much above the tops of the houses, so that the tallest of them could in places be just seen peering above the dark cloud which rested upon the earth. When one was able to get outside the veil which hung upon the metropolis, its cause could be seen pouring down from every chimney which was acting as an upcast for a fire. The sun was quite invisible from the surface of the ground, but appeared as a copper-coloured disc from the upper windows in the houses in the Oxford-street side of Hyde-park. The sky was comparatively cloudless, but there was no warmth in the sun's beams over London, no comfort in his aspect, and not a shadow of heat could be collected by a pocket lens, although outside the pall the sun was shining brilliantly, and the country enjoying a perfect summer's day. The air was warm outside, temperatue 64°. The grass in Hyde-park was perfectly dry, as shown when the hand was passed over it. The particles of black matter, which were collected on a similar occasion, on a microscopical glass slide moistened with glycerine, shewed the same appearances in the field of the microscope as that exhibited by a similar slide designedly exposed to the smoke of a common chimney, viz., particles of unconsumed carbon and some oily matter, which was of a tarry nature. There was also the other accompaniments of smoke in the air,—viz., an acid gas, which acted upon moistened litmus paper, and which, by the irritating effect which it had upon the bronchial mucous membrane, was something more than carbonic acid. Other tests showed that this was sulphurous acid, which existed so abundantly as to counteract the naturally soothing effect of the carbonic acid, which was also largely in excess. I have sometimes found ammonia, but on this occasion it was neutralised, if present, by the acid, and yet left sufficient of free acid to decidedly affect the bronchial mucous membrane. The air was not tested for ozone, but that none existed was very manifest. The openings from the public sewers gave unmistakeable evidence of a greater warmth below, which, telling upon the contents of the sewers themselves, produced a fermentation, obvious as to its origin; but, curiously enough, the smell was not perceived a few yards away from the gratings. I may be allowed to mention, in passing, that the presence of carbon and sulphurous acid in the atmosphere appeared to be of great use, altering the character of the emanations from the public sewers, and giving the inhabitants of this great city a present protection from the effects of one of the greatest engineering errors of the present time—one of those great mistakes which engineers are constantly making uuder the name of sanitary work, whilst they are breaking a fundamental or canon law of sanitary science. I may, perhaps, be allowed to give the ground of that law. Any sewer which becomes a sewer of deposit, either by accident or design, has been constructed in defiance of sanitary law, and must in due course bring insanitary results to those exposed to its influence: it is wrongly constructed, and is a mistake. I mention this point now, to show that the smoke of a great town is not an unmitigated evil, but that it has a mission, so to speak, which is not yet completed. It is a truism, nevertheless, that two wrongs cannot make a right. The right to pure air

ought not to be sacrificed to the necessity for impurity, because other works have failed to effect the object for which those works should have been constructed.

I must, however, now give further proofs that smoke is the cause of the darkness which these fogs produce. Fogs of all kinds are limited in the extent to which they reach upwards. Natural fogs do not reach an altitude sufficient to shut out daylight, for as soon as their ordinary depth reaches a certain extent, the fog lifts and floats away, or the meteorological changes are such as lead to its dispersion. So also with smoke fogs; they do not reach any altitude, and very often scarcely rise above the chimneys which pour them out, yet they often produce complete darkness. This is never seen in day-time, as the result of a wet fog, when there cannot be a suspicion of fuel-smoke. Has a darkness ever been produced at mid-day on the Scotch moors or among the Irish bogs? Has it ever been seen on the great ocean between this and the Western Continent? Fogs there are, intense and deep; shutting out sight as far as distance is concerned, it may be even limiting vision to a few feet; but there is always a whiteness about it, quite different from the fog of a great town. A pocket lens will easily show that this whiteness is due to minute particles of water, capable themselves of transmitting light, but which transmission, whilst decomposing an individual ray, yet re-combines the elements into white light again, and when the particles are filtered out by means of pure cotton wool, are shown to be composed of water. Not so a large part of the particles which are found in the fogs of great towns; they consist, in great measure, of organic matter, capable of absorbing light, not transmitting it, and, when filtered out of air by means of cotton-wool, are black-looking matter, with oily particles of some hydrocarbon oil of a tarry consistence, which seems to envelope the atom of water which is with it. Sometimes the oily matter is in excess; sometimes it is the solid carbon which is more abundant. By long continued exposure of plates of moistened glass, some crystals of sulphate of ammonia may be obtained, and also occasionally other kinds of *débris*, but, on the whole, the sooty particles are largely in excess of everything else.

The other day I went down to Reading, by the Great Western Railway. At Croydon the air was clear, the sky bright, but it was cold. London itself was dull and somewhat foggy. After leaving Paddington, a dark bank of cloud, resting upon the earth and reaching to an elevation of some hundred feet, limited vision to within a few yards of the line on its left-hand, whilst on the right the view was uninterrupted as far as the landscape allowed. The bank followed a straight line; it did not follow the turns and windings of the river, as would have been the case if it had been due to water as a main cause. The wind during the morning had been quietly veering from north to east, and with it came the line of smoke as clearly marked as any cloud could be. That it was not due to Father Thames was clearly seen when, on another occasion, the wind changing to north, a similar dense cloud came with the change of wind, and hung over the Sydenham hills and the heights about Sutton and Banstead, whilst the valley of the Thames above London was comparatively clear. I have often watched these changes of wind from different parts of the Surrey hills, and seen the Crystal Palace disappear from view, although, at the place at which I was stationed, the sun was shining brightly, and shortly before the eclipse of the palace took place, the sun's rays were reflected most brilliantly upon the glass of that building. These observations have been made when the thermometer has been somewhat falling, but the other conditions requisite for the production of fog have not been present in those parts of the country where fogs are usually found, and the soil, being gravel and chalk, cannot be accused of being fog producer.

In my own neighbourhood the densest fogs come from the north, and these consist of a dark pea-soup atmosphere, which renders our district most unsatisfactory, whilst it lasts, as a health resort. Similar conditions are sometimes to be met with in the most favoured places. I was at Brighton on last Lord Mayor's day. It was a beautiful day in the Weald district. The country looked lovely in the autumnal tints produced by decaying vegetation, brought out by a November sun. The north side of the South Downs were perfectly distinct in outline, without a trace of mist upon them. There was a lovely sunset as seen from the new pier; there was nothing to limit the sight seaward but the distant horizon. Not so in the town of Brighton itself. Just after sunset the lights on the north side of Regency-square could scarcely be seen from the Parade, whilst the lighted gas lamps were quite invisible at the northern ends of the streets which run at right angles with the King's-road. Yet the sky was clear, the stars shone brightly, and there was no reason for the heavy and murky atmosphere in London-super-Mare on that evening, beyond the smoky chimneys, the soot from which could be seen pouring down into the streets and squares of the place, and as these were at right angles with the wind, there was no easy escape. The wind was from the west; it freshened into a gale late in the evening, and cleared the smoke away. It is, however, a curious fact, that Brighton, which is a place beyond all others free from fogs, in the common acceptation of the term, suffers occasionally from coal-smoke and its consequences as much as any part of London, whenever there is a calm with the slightest possible amount of wind from the west. If the barometer is high, and the thermometer low, with a north wind, the setting sun is seen as a dull copper disk, which disappears from view long before it ought to be lost to sight; whilst if the wind blows on to the land from the sea, there is no interference with the beauty of the retiring orb of light. I have witnessed this phenomenon on several occasions, so that one may draw the inference that, with a still atmosphere, high barometer, and falling thermometer, with the wind from the west or north, there will be a murky cloud settling down upon the place at sunset, which, but for the sea shore, would soon render Brighton, as far as fog is concerned, little better than the East-end of London. How is this to be accounted for? I think that the 110,000 fires which are burning there, in a narrow band under the Downs, and which, as the shades of evening come upon the place, are thoroughly replenished with small

coal, lead to dense volumes of smoke from almost every chimney, and produce this change in Brighton. The cause is one which man produces to serve his own purposes, and which, therefore, man can remove.

It is thought by some that smoke is only a minor agent, that there are other and irremovable causes; that smoke from coal is secondary only, and its removal would be useless. It is thought by others that we have only to put the Smoke Act in force, and stop the discharge of the clouds of smoke from factory chimneys, to remedy the evil. Others think that the main cause is in the marshes, which, as far as the valley of the Thames is concerned, occur between its rise and its fall into the sea; they think that land drainage would remedy the evil; others refer them to the clay soil which constitutes the London basin. The irremovable causes do not account for the darkness and noisomeness which, if such were primary parts of fogs, would be felt most on the Scotch moors and the high seas, but which are in reality never found there. No one ever coughs up a quantity of matter very much like a decomposed leech when out on the moors, or among the bogs of Ireland, unless he has just come out of a coal-pit; but no one can be long in a real London or a Manchester fog, without expectorating very frequently a nasty bit of filth, which shows its nature upon its very surface. We should have these conditions most frequent in places most likely to give rise to them, if water was the main cause; but fogs, produced in such situations, are always white fogs, and cannot be mistaken for a town-made fog. They may occur in London, as well as elsewhere; they do rise in London, no doubt as they do in all clay deltas, if the conditions are present which cause the descent of coal-smoke, they add very much to the dangers and difficulties of the occasion; but white fogs begin on the ground, and grow upwards, whilst the black or yellow fogs come down. White fogs are bearable, if alone; they are not dangerous to life, except in a very minor degree, which may show itself in the Welsh valleys, on the Yorkshire moors, or the lowlands by the sea.

Those who think that an enforcement of the Smoke Act, as it now exists, would greatly diminish the evil, are not quite aware of the main cause of the mischief. There are no factories in Brighton, there are very few at work in London on Sundays, and yet some of the worst fogs I have ever witnessed have been on autumn Sunday mornings, between the hours of ten and two. The only reason for Sunday fogs, is the fact that on that day the London poor, and a large part of the middle class, dine at home in the middle of the day; that there is always a good fire prepared early in the forenoon, by the almost simultaneous heaping on of loose Newcastle or other small coal, and, as a consequence of that simultaneous fire replenishing, there are dense volumes of smoke from every house fire in the metropolis, about the time at which cooking commences, which slowly gather into some part or other of the district. On other days a great part of the cooking is done at other times, more of it towards sundown than in the morning; but, on Sunday, it is in the morning, and, as a consequence, there is a capacity to produce fog if the meteorological conditions favour it, which is not found on any other day in the week. In Brighton, the simultaneous charging of fires occurs about sundown, and the greatest volume of smoke is visible soon after sunset, when the days are shortening and the air grows cold. In the metropolis it is at midday on Sunday that there is always, if the wind is trifling and the barometer high, in some parts of the forest of houses, a cloud of unconsumed carbon, which obstructs sunlight, and in the aggregate, produces as much evil as did the pestilence of former days. Sudden deaths from the rupture of blood-vessels in various parts of the body are not infrequent, and other illnesses are common, which, sooner or later, have a fatal termination, but which are not referred in the Registrar-General's reports to the real cause of the untimely event. The effects upon human beings are innumerable. The irritation set up in the eyes leads to much individual suffering, and a great aggregate loss, whilst similar effects upon an irritable mucous membrane causes pneumonia, bronchitis, asthma, and a host of maladies, both painful and weakening. The injury to the skin is not the least part of the mischief, blocking up the pores, and interfering with perspiration, doing for man, in a minor degree, that which produces a much greater loss, to plant life, in a pecuniary point of view, and which, in its effect, cannot be estimated. I lay great stress upon the Sunday development of fog, because it is very striking to those who observe it from the outer side of the great centre. I have done this for some years, and have marked the way in which the London pall has invaded my own district, producing now and then a necessity for gaslight at mid-day, when I have been dining with my family at a distance of ten miles from St. Paul's. I have gone up to London after that, leaving behind me a dense black cloud resting upon the earth, finding it less dense at New-cross, not much fog in the City itself, and the North of London has been comparatively clear. On these occasions the wind has been calm in the morning, and blowing slightly from the north towards mid-day, and I have been told that there had been a fog in London in the morning, but that it cleared off about the time at which it invaded our district. On these occasions the barometer has always been high. One day I went down to Greenwich when Croydon was enveloped in London fog. It was not one quarter so intense at Greenwich as at Croydon. On another visit it was slight at Croydon but intense at Greenwich. The wind in the first instance was north with a point to the east, in the second it was north-west by west. In both instances it is quite certain that the wind did not cross the Essex marshes or any other marsh land before it reached either of the places I have mentioned, but the fog had simply been brought from the forest of houses which constitutes the metropolis of Great Britain. My early impressions were that the main cause of London fogs was intimately connected with marsh or clay land, so no doubt wet fogs are increased by those districts which are yet undrained, notwithstanding the incubus of an easy money market. Observation, however, has told me that only a moiety of fog is due to this cause, and that that moiety is the least injurious part. I have seen the fog grow, as it

were, within the radius of houses, coming down upon the ground, not ascending from it, presenting its first indications in too close proximity to the chimney top to lead me to doubt as to the source. Those who always live within the radius of the producing cause are often unable to see the changes which take place within the influence of that radius, but which changes are distinctly visible to those outside.

If the Essex marshes were the greatest factors in the case, the fogs themselves, in their invasion of other districts, would always have a distinct reference to some part of the Thames delta. The invasion of the table-land about Croydon and the Surrey-hills is not traceable to that source. A north-east wind does not give us worse fogs than those we get from the north and west. Our darkest fogs come most distinctly from the north; never from the east or south or west. I can predict with certainty the presence of dense fogs in Bermondsey and the City without visiting those places. They are always bad on those spring mornings when with us the air is clear, the sun shining brightly, and not a cloud in the sky; there has been a morning frost, the wind being distinctly south, but moving very slowly; our season ticket-holders on the southern lines then know that, as soon as they get into the New-cross cutting on the Brighton line, they find a dense fog, which grows darker as they get to Bermondsey, and in the City the gas is necessary. A white and wet fog does not by itself ever produce a necessity for gas, but when the smoke comes down as the white fog rises, there is difficulty, danger, and darkness all around.

These fogs are perfectly free from any suspicion of mixture with air from the Essex marshes. The simple fact is, that the smoke shuts out the warmth of the morning sun, which is reflected back again from the cloud below the chimney-pots, instead of warming the earth. I have known, on several occasions, a complete change of wind take place towards the middle of the day, the course being from south to west, then to north-west, finally resting in the north. With that change the sun becomes obscured, and is only visible as a dull copper disc, a cold raw feeling pervades the place entirely banishing the genial air which had so delighted us in the early part of the day. The change has brought us London smoke and London air. The sun loses his beauty and his warmth much more effectually than when clouds of the proper kind obscure him. He only shows a dull, copper-looking disc, which is very conclusive as to the presence of particles of unconsumed carbon in the air. The copper-looking appearance is quite different to that which arises during its natural eclipse; it is somewhat like it, but it produces a much colder feeling in the air, and makes one feel positively miserable and wretched.

The moon also tells us very clearly when the air is loaded with fuel smoke; its colour is altered, its silvery appearance is lost. It is quite different to that appearance which it presents when simply obscured by light fleecy clouds, themselves a near approach to an ordinary fog.

I have a suggestion to make as to cause. I have not been able to prove the truth of the suggestion, for it requires electrical apparatus which I do not possess, but it appears to me capable of explaining the development of smoke fogs. Diffused electrical charges, concentrated over a small area, must be taking place in large cities from chemical acts, from the various manufacturing agents always at work, from magnetic developments consequent upon the close proximity of 3,000,000 people, probably as many animals, and, in winter time, certainly as many fires. This electrical development may be suddenly manifested in one direction at one time, in another direction on another occasion. Is it not possible that it may produce those atmospheric calms which occasionally precede local thunderstorms over our great towns? Is it not possible that the 3,500,000 fires which are sometimes lighted in the metropolitan area, and which cause a rush of hot air upwards, being positively electrified, may have a repulsive action upon the unconsumed carbon, in a negative state, and cause its rapid descent towards the earth, but to which it is not attracted? This might account for the reason why these fogs arise when the barometer is high rather than when it is low. The surface of the earth is colder than the upper regions of the air, and that coldness is not dissipated because the rays of the morning sun are reflected from it by the surface of the cloud, or are absorbed by the particles of carbon. One would expect the exceedingly light organic particles to go up with the heated air; there appears to be a repulsion between the particles of carbonic acid and the soot particles, for the air which contains excess of soot does not always contain excess of carbonic acid. There does not appear to be more carbonic acid in that which floats away from a chimney-top, than in that air which is collected at a corresponding resistance (40 feet), from the chimney, but which is comparatively free from smoke. It might be thought that the largest quantity of carbonic acid would be found close to the surface of the earth, from the greater specific gravity of its particles; but this is not so. There does not appear to be more carbonic acid close to the ground, than when the air has been collected twenty feet from the surface. With soot, the rule is contrary, the densest parts of stationary smoke fogs are nearest to the ground. This density shows itself in several ways. It obliterates light completely; but the most curious effect is the obliteration of sound, which prevents one from perceiving the approach of moving objects until they are close upon you, and moving vehicles suddenly appear like ghosts upon the scene; a noise upon the top of a building is heard much more distinctly than one near the ground. On the September Sunday to which I have already alluded, the noise from the traffic in Oxford-street was heard much more clearly than that from the middle of Park-lane, although I was in a part of Hyde-park much nearer to the latter than the former; at the same time, vehicles passing by the Wellington monument, where the fog was thickest, could not be heard at all.

It is reported that a so-called dry fog is sometimes observed in Belgium, where it is called bog or heat smoke, and is imputed to its right cause, viz., the combustion of peat grounds. If we could eliminate the particles of solid matter from the atmosphere, London and other large towns would be no worse as regards fog than other places, and

those districts which, like Croydon (in reference to certain winds), are to the leeward of the great city, would not suffer in the way we do now from its perpetual burning. There are some points connected with the subject which have been raised by scientific men, into which I need not enter. I have committed myself to the theory that it is smoke, caused by the destructive distillation of coal and other fuel which causes the greater part of our evil; that it is not a "radiation fog" or a "Scotch mist," or simply a mist from the bosom of Father Thames or the Essex marshes, or the London clay. The literature which has been published regarding fogs is not extensive. My friend, Mr. Dines, read some practical remarks upon dew, mist and fog, before the Meteorological Society, which is published in that Society's Journal for July, 1879, and which contains almost as much information upon the subject as is generally known. Mr. Dines also says, in a letter to me, that, "It is now pretty certain that the fog grows upwards, and that just above the fog the air becomes (rather abruptly) several degrees warmer." He then also adds, "at present I cannot make up my mind whether the roofs of houses, slate and tile, radiate like grass, and so cause mist and fog; they are bad conductors, and, therefore ought to be good radiators." Mr, Dines also adds, "that, in my opinion, the water has nothing to do with London fogs." In this opinion I concur. It is said that the immense combustion which takes place from fire and gas in London, naturally produces an immense quantity of watery vapour, which is precipitated at times from the chimney tops as fog. Whether this is so or not, will in no way interfere with my conclusions, for that fog would be a white fog, like the steam from a locomotive, if no carbon or hydro-carbon were discharged with it. Dr. Frankland is of opinion that the water particles become coated with votatile hydro-carbon, rather than with soot. This cannot be borne out as true on all occasions. The matter filtered from air, such as that of September 26, contained much more solid carbon than volatile oil, as a few rough experiments with cotton wool easily proved. The size of the particle of water in the mist or fog is of no consequence, because I contend that, if the destructive distillation of fuel, as now conducted in most fire-grates, could be limited, the noisomeness of a London fog would be done away with; and it will be outside my point to take up your time with these details. The radiation from roofs may be a determining point in changing the direction of a magnetic current, and may, perhaps, produce different magnetic states in the air above our great towns, as compared with the mass of matter below, and is worthy of a thought. It may be a determining point as to white fog or no white fog, but there is no practical result to be gained from considering it. Some wise men ridicule the notion that unconsumed carbon is the cause of a London fog, and they write that the quantity of carbon in a cubic foot of air is so infinitesimal as to be almost nothing. Need I say that my engineer critic is evidently not aware that a difference of only 200 grains in a million, or only one grain in 5,000, in the case of carbonic acid gas, and even a smaller quantity in the case of oxygen, will make all the difference between a healthy and an unhealthy atmosphere, and on his own showing, the effect of smoke in deteriorating the air is far greater than this. My critic convicts himself as being in the position he wishes to place me in, when he accuses me of ignorance of my subject.

Most elaborate tables have been prepared to show us the quantity of sunshine which Providence has bestowed upon us during the past year, and a good inference has been drawn, indicating that each hour of the sunshine has been worth "so much." Let me ask how much sunshine has fuel smoke deprived the Londoner of, during the past two or three years. How much sunshine has this country been deprived of, and how much has vegetation suffered from this cause. Let any one stand, as I have done this autumn, upon the Cumberland mountains on a fine day, note the position of the wind, and if it comes from one of our manufacturing districts, he will observe a haze which limits vision, and which an air filter will show to be due to organic matter, referable for its origin to the destructive distillation of coal and other fuel. I have watched the smoke from the Lancashire and Cumberland factories, finding its way across the sea, in a distinct cloud-like mass, which, impinging upon the distant hills, has shut out sun-light as effectually as if it were London fog. How much it interferes with vegetation is patent to every one; and one has only to walk through a field of cabbages, in the neighbourhood of London, when wearing a pair of white continuations, to get evidence enough to prove the truth of my proposition, without requiring philosophical instruments for the purpose. Is it not ridiculous for anyone to assert that this effect is a trifle? How little can such critics know of the economy of nature; how little can they appreciate the goodness of the Almighty, who has, in vegetation, given us a means whereby we may cause the removal of the natural impurities that must arise in air, viz., the carbonic acid and albumenoid ammonia, which must be produced where people most do congregate. We impede that vegetation by our carelessness or our cupidity, and that which might make our cities much more beautiful and much more healthy than they are, can scarcely get a footing in our midst. But it is not vegetation alone which suffers. As I have said before, the life of man himself is materially shortened, and much mischief results to him in various ways; not only man, but his own works are rendered less durable. The injury to works of art is manifest. The glass shades over the frescoes in the Houses of Parliament, the condition of the masonry of the houses themselves, the crumbling outer halls of Westminster Abbey, the roughness which has replaced the smoothness of works of art in the old Abbey, and even in St. Paul's Cathedral, all points to the presence of matter in our atmosphere which the chemist tells us to be sulphurous acid derived from coal. Then look at the hideous erections with which our houses, and especially our public buildings, are disfigured; smoke preventers, smoke curers, horrible contrivances put up in the higher regions, pretending to make the rooms below in a habitable state. It would be interesting to know how many architects have been consigned to lunatic asylums, in consequence of this incubus upon their architectural works. A survey of London from the top of one of the high buildings in its midst, is one of the most extraordinary spectacles which can be conceived.

Tubes of the most outlandish shape, and most peculiar construction, obtrude themselves everywhere, and can probably only be equalled by a similar state of things in the underground drains. The aim and object of these hideous excrescences, both above and below ground, would appear to be to make the atmosphere, subsoil and aerial, as unwholesome as possible.

There is an important point upon which men differ considerably, viz., are fogs worse now than they used to be in former times? Several correspondents have assured me that they are no worse now than in the early part of the century; but need we argue this point? Given a clear sky, a high barometer, a falling thermometer, with but little wind, and there is not any day in the whole year in which a dim atmosphere will not be found at sundown somewhere in or around London. Can any one assert that this has always been a feature of the metropolitan district? Dense fogs, no doubt, have at times always occurred, and are primeval; but there are no substantial facts to show that pea-soup fogs are so. They stick to the point of origin; they may invade other districts at a distance; but when London was only a tithe of its present magnitude, were scarcely perceptible ten miles away. This is borne out by a verse which Gilbert West put up in an harbour at West Wickham, a village four miles to the east of Croydon, and which I find in Garrow's "History of Croydon"—

"Not wrapt in smoky London's sulph'rous clouds,
And not far distant stands my rural cot;
Neither obnoxious to intruding crowds,
Nor for the good and friendly too remote.

And when too much repose brings on the spleen,
Or the gay city's idle pleasures cloy,
Swift as my changing wish, I change the scene,
And now the country, now the town enjoy."

This verse, put up a century ago, would hardly now apply; sulphurous clouds reach much further than West Wickham, and we in the suburbs cannot so easily escape from a nuisance even then recognised as peculiar to a great city.

Only a week ago, a veteran member of the Strand Board of Works is reported to have said that some fifty years since wax could be bleached at Hammersmith and Shepherd's-bush, but that now wax-bleachers have to go much further away from London, before they can get sun-light sufficiently clear to effect their object; London smoke interferes effectually against the particular industry of wax-bleaching. Was there ever such a fog in South Kensington, before it became the dense suburb that it now is, as was seen there on the second of this month? I will, however, now leave the consideration of the cause, and try to suggest a remedy.

It is much easier to point to a nuisance than to get it removed; I always object to criticism, unless it shows a better way of doing things. I object to overthrow an institution, without being provided with something better to put into its place, even if that institution is a nuisance. The overthrow of the domain of fuel smoke might be purchased too dearly. There is something so endearing and so national about our domestic hearth, so captivating about the ability to poke a fire, that I should never expect to remove these comforts from our midst; neither is entire removal necessary. The ability to poke a fire is the one thing which preserves many a mind from downright insanity, and to take away the power would consign many an unstable mind to a madhouse. The thing is not to be done, therefore, without due consideration. Thousands of fires, nay tens of thousands, would not produce a London fog, spread about, as they might be, over the 300 square miles which constitutes the metropolitan district. A few such fires would do harm, and if such fires, being a luxury, were made to assist in performing a duty towards those who could not afford the luxury, good might come out of evil; though I would not support the notion that it is right to do evil that good may come. The question is how are smoking chimneys to be got rid of. It is a process which the Society of Arts, with all its array of powerful names, will not be able to effect. An appeal must be made to the Legislature upon the point, and I suggest that the Society be foremost in making that appeal. Let us ask them to pass such laws as will help forward the object which we have in view, for public opinion, public spirit, and philanthropy will not alone be able to effect it.

I believe that a short Act would be sufficient. That if local authorities had the power to levy a tax upon every fire-place so constructed as not to consume its own smoke, the smoke nuisance would disappear in a very few years. They should have the power to use the proceeds of that tax in the purchase of the gas and water works of the district, and so enable local authorities to provide the capital necessary for the purchase of these works without having to add materially to the local rate. Gas, like water, has become a necessary of life; no large town can carry on its work in the world without gas. It is false political economy for dividends from gas and water to be paid out of the life-blood of the country. Its property should provide the capital for the purchase of such works. That capital should be sunk at once, and the consumers of both gas and water should only be called upon to pay the cost price of the product, with such other charges as might be sufficient for the maintenance of the works in an efficient state, and when extensions are required, the property requiring the extension should pay the cost.

The practical experience of large consumers tell us that gas even now can be produced in the neighbourhood of London at 1s. 6d. per 1,000 feet if the charges on capital account are kept out of the balance-sheet, and they publish the fact in their own accounts. I take it, therefore, that 2s. per 1,000 would cover the expense of production, distribution, and maintenance; and if gas was supplied at that price in London, it would soon find favour as a cooking and warming agent, and would greatly assist to extinguish the smoke fogs (provided means were taken at the same time to put an efficient law in force against some of the most notorious of the company offenders). There are, probably, 4,000,000 fire-places in the metropolitan district; an average tax of 20s. upon each of these, payable after two years' notice, would cause the removal of three-fourths of them, and the remaining million would provide a fund which would, for a time, go some way towards paying off principal and interest upon the purchase of the London companies' claims in their works. If three-fourths of the fires were deprived of their smoke, the atmosphere of London would be deprived of much of its noisomeness. This might be still further diminished by rendering it incumbent

upon those who continued to have open fire-places to burn only that coal which had been partially deprived of its smoke-producing qualities. Indeed, the sale of any other coal to private consumers might fairly be prohibited, and a considerable increase might be made in the coal dues upon that part of the coal which continued to be distributed within the metropolitan district when that coal was intended for consumption in open grates. These charges would, in a few years, remove nineteen-twentieths of the noxious matter which is now discharged into the atmosphere of the metropolitan district. It is probable that the production of a fog is something like the production of a frost. The temperature must fall below 32° before a frost begins at all. If the temperature is high, the reduction for a degree or two is of no consequence. It is only when near to the freezing point that it becomes important as regards the production of ice. So it is also probable that, to produce fog, there must be a concurrent smoke from a certain number of chimneys within a given area, and if that number is not reached, there will be no fog, even when meteorological conditions are such as may favour its production.

My proposition will be met by innumerable objections; all great social changes are so met. It is only by answering those objections, or showing them to be unsound, that real progress will be made.

First, then, as to gas fires, which I suggest as alternatives for open fire-places. I am told that they are injurious to health, that they are comfortless, that they make the air of the room so dry, that they smell offensively, and that the heavy gases which are formed at the base of the fireplace will find their way into the room. These are fair arguments against bad workmanship, but are not sound as against gas fires. I have had a gas fire for some years in my consulting-rooms and library, and no one, at first sight, can know it from an ordinary coal fire. It never smells, and warms a large room thoroughly; there is no dust, and no work for the housemaid to do, and no destruction of books and papers from dirt. But I must not poke it, and I must not burn rubbish upon it. These are, next to its cost, its only disadvantages. A gas fire cannot dry the air of a room to a greater degree than any other fire. If a smell comes from it, the fault is in the work or the stove construction, and would happen at the same place with any other material. If I had gas in all my rooms, I could do with one servant less in my household. Chimney sweeps, who are now necessary adjuncts to every house, would find their occupation gone, and the mischief which soot and dust produces in every house would not arise. This would effect an enormous saving in our domestic outlay, and our domestic works of art would last much longer than they do under our present *régime*. Common grates need not be removed, gas fires can be fitted to any ordinary grates, and the only expense need be the cost of laying on the gas. I shall be told that it will be quite impossible for the poor to do this. It is not a thing which the poor should be called upon to do. The tax upon open fire-places should fall upon the landlord, and in the case of weekly tenements, the landlord should collect the charge for gas when he collects his rent. If the rent is not paid, he should have the remedy in his own hands, by at once cutting off the gas supply. I am so satisfied of the power of our stove manufacturers to meet this point, by constructing stoves which should give a maximum amount of heat with a minimum amount of gas consumed, that I should hail the change as one giving an immense boon to our labouring population, by providing them with warmth without waste, and taking from them that tremendous source of dirt which smoke produces among them, and which manifests itself upon the faces and clothes of the children of our poor population. The pocket saving would not be the least part of the work, for no one can watch the waste which the poor man has to suffer in his efforts to make a little fire to burn up, without feeling that the change would be very much to his interests. Whilst, as far as the gas rental is concerned, the poor should be called upon to pay the average weekly cost in advance, just as they now have to pay for the coal before it is consumed. There would be no injustice or hardship in this, provided the law gave them a right to a drawback upon that which they did not consume. The enormous advantage of a gas fire in a sick room has only to be felt to be at once appreciated. There is no waking up the patient by having to poke the fire and put on coals; there is no sudden discovery that the fire has gone out whilst the wearied nurse has slept, at the moment, perhaps, when it was very important that the air of the room should not get chilled. Indeed, the advantages of being able perfectly to regulate the heat of the room in such cases is immense. Those who do not like a gas fire need not be obliged to have one; they may find a much cheaper substitute in the beautiful slow combustion stoves which are now very generally manufactured. I would especially refer to those of Mr. Doulton, at the Lambeth Potteries, and which are formed of fire-clay; I prefer these to those made of iron. The fire-clay radiates heat much better, without depriving the air of its health-giving qualities. No one can have compared the heat given out by a common fire-place, having a fire-brick back, with one with only an iron plate, without at once giving the palm to the fire-clay material. These stoves provide that nine-tenths of the heat produced by the fuel consumed shall be utilised in the apartment, and not sent up the chimney, as is now done from ordinary fires. These stoves are a great advance upon the ordinary iron stoves. The air is not altered in its character by coming into contact with hot metal. The stove is not a nuisance in its appearance, but may be made an imperishable work of art, which will bear ill-treatment, and only want washing when dirty, instead of paint or blacklead, which, when used, smells most abominally all over the house. I think it very important that the use of fire-clay should supersede that of iron. Coal, as now burnt, is burnt to waste; in all other fire-places, and in great numbers of ordinary stoves, the heat generated is dissipated in the air above our houses. There was a scare some time ago regarding the exhaustion of our coal-fields. The bare possibility of such a thing should lead the Legislature earnestly to consider the fact that not more than one-sixth of the coal, now consumed, is usefully employed, and its waste might very fairly be prevented.

There is also another question which this change would solve, and which would be of immense advantage to the local authorities of the metropolis. Tens of thousands of loads of ashes which now block the dust-bins, and are such an incubus to the Vestries, would then have no comparative existence. The organic matter which the Vestries would have to collect and to dispose of could be easily dealt with by fire. There would be other changes besides a purer air; it would give relief to the traffic of our streets by taking out of them the long array of coal waggons and dust-carts which now delay other and more important traffic; and the Vestries would find a solution to a question which at this moment is exercising their ingenuity to a very serious extent, without their being able to find a solution for their difficulty.

Then look at the architectural advantage in an æsthetical point of view. Imagine London without those productions called smoke preventers, and those hideous chimney stacks which spoil all proportion. Think of the incubus which would be removed from the architect's mind when he felt satisfied that the chimney doctor would not be required for the purpose of spoiling the appearance of his edifice.

It will be urged that taxes of the kind proposed, are all wrong—that it is going back to a tax which, once upon a time, produced rebellion in our land. Then the window tax is instanced as one which had to be given up. But the window tax was quite the antipodes to the smoke tax; one was the means whereby light and air was shut out, the other is not for the purpose of raising a revenue, but to put down a nuisance, and to lead to the purification of the air. I propose a tax in preference to a penalty. Penalties require persons to enforce them. The infliction of a penalty is invidious, when it has to be enforced against our neighbours and our equals, and when it is possible that the magistrate himself may be an offender against the law. There are many difficulties which are shown in those places, in which the smoke nuisance from manufacturing premises is even now allowed to continue, in spite of the Smoke Act —and why? Because the members elected to serve on Local Boards are themselves offenders against the Act; and the magistrates who have to enforce the law, are themselves law-breakers in this very matter, it follows that in places like Warrington, Wigan, and Manchester, the law is defied and penalties not enforced. This would be even more certain to follow if there were to be penalties for smoking chimneys. But make it a heavy tax, which all who do not comply with the law must pay, and the difficulty vanishes, as far as the money question is concerned.

The power to proceed against the manufacturing offender should be placed in the hands of a public prosecutor, and should not be left with the local authority who, as at Bow and Stratford, allow the law to be a dead letter, because if enforced, it would be upon the members of the local authority or their friends that it would have to be levied.

Any law for the reduction of the smoke nuisance would only be partly effectual which did not touch most heavily the greatest offenders, viz., the railway and steam-boat companies. One great reason for the greater intensity of fogs in the present day is the fact that, as soon as a white fog settles down upon the metropolis, if it be attended by a falling barometer, thousands of cages are brought out all along the railway lines, and are banked up with small coal and breeze instead of coke, and which give out dense clouds of smoke. They tend to render traffic on the railway more difficult than it is elsewhere. These cages contain fires ostensibly for the purpose of warming the watchers who signal the trains. I say ostensibly, but that they do not effect their object is but too evident from the appearance of the poor men themselves. If, instead of providing such fires, the companies would provide the men with proper dresses, such as arctic voyagers wear, there would then be no occasion for the fires, and the men would be much more comfortable. In addition to this change, which humanity ought to dictate, it should be a public prosecutor's duty to compel companies to run engines which really consume their own smoke, and the dense volumes of black smoke from steamers on the Thames should be ruthlessly put down.

I know that my proposals will raise up a host of antagonists, especially among those who believe that they are owners of a patent or a fuel which, if Parliament would but compel the people to use it, would stop the nuisance. I think my proposal will promote their interest much more than any legislation in the direction they contemplate. A still more powerful opposition will arise from those who believe that they have vested rights in the perpetuation of the nuisance, not the least of which ought to come from the sweeps, an honest and industrious set of men, who would suffer most from the change; but the most powerful opposition would be from those who are profiting by the mischief, and making immense sums of money by the perpetuation of the nuisance. I am in doubt as to the best mode of proceeding; but this meeting will, I feel sure, endorse Mr. Micawber's opinion that "something must be done," without following that gentleman's example, but will advise that action be taken of a determined character. I would propose that the Home Secretary be approached, and that he be urged to procure the appointment of a Royal Commission to inquire into the whole subject. I have put before you my own views under three heads. They are—

1. The causes of the intensity of town fogs.

I refer these to fuel smoke, which I contend to be an unnecessary adjunct to fire. That the method now used for warming our houses and cooking our food is wasteful in the extreme, and five-sixths at least of the developed heat is lost, and much of the fuel passes away unconsumed.

2. The means which should be adopted to prevent these causes continuing in operation.

These means should be the production of gas at a cheap rate, so that it might be used for cooking, and in many cases for heating purposes also.

In reference to this point, I would observe that the use of gas for lighting purposes will pass away; it would be to the interest of the companies that heating power should be developed in the gas manufactures rather than lighting, and that it would be promoting the object we have in view if the sale of coal was prohibited in the metropolitan district, unless it had been previously deprived of its smoke-producing

quality. That a tax upon fire-places not so constructed as to consume their own smoke would effect this object, which might also be assisted by a heavier tax upon the untreated coal when sold for public consumption in the metropolis. That the proceeds of these taxes should be used by the local authority in extinguishing the present commercial companies who manufacture gas and distribute water. That the use of closed stoves should be encouraged as much as possible.

3. That the steps which should be taken to promote these objects would be best met by urging upon the Government the propriety of appointing a Royal Commission to inquire into the whole subject, and who should formulate the grounds upon which legislation should be established, and prepare the way for the introduction of a Bill into Parliament for the purpose.

DISCUSSION.

The Chairman observed that Dr. Carpenter, in his excellent paper, had noticed the existence of fogs in the mind. But for the existence of such fogs in the Legislature, in 1855, the metropolis would have been, in great part, relieved of the evils in question some years since, for clear measures had been prepared, which, in principle, must be resorted to now. He (the Chairman) remembered, as one of the first incidents of his sanitary service, a local officer pointing out to him from an eminence, in a rural district, a white fog which at evening-tide was spread evenly like a blanket over a valley beneath. That regular fog, the medical officer stated, covered the bulk of his patients. Outside of the fog he had scarcely any but midwifery cases and accidents. Such fogs are always lowered and frequently removed entirely by the process of land drainage. The addition of the sewer gases and of soot to the rural fogs would compound a fog of much the same primary elements as the London fogs. A great part of the interior-covered site of London was supersaturated with the fouled waste water, amounting to forty or seventy millions of gallons daily. The death-rate from attacks of epidemic disease in the lower levels of the metropolis were found to be double the rate of attacks in the higher levels, which, however, were subject to the ascending emanations from the lower levels, as well as from intermediate flat tables. Then there were the stagnant surfaces of full one thousand miles of sewer of deposits, as well as of bad house-drains. The whole of this source of contamination would have been removed by the adoption of the self-cleansing system of impermeable sewers proposed, and removed at half the expense of the stagnant system. The effect to be produced by the substitution of a self-cleansing system was the same as that produced by heavy storms, when all felt the unusual freshness of the air they breathed. Next there was, outside the covered areas, extensive tracts of marshy land, so named, the Essex and other marshes, which would be benefited in increased production by subsoil drainage. Fogs occurred in the greatest amount when the wind was easterly; and on those occasions, marsh diseases and ague were more frequent (for the most part in the portions contiguous to the marshes but extending to the western parts of the metropolis) than was supposed, as deaths, originating in the marsh diseases, where not entered as such in the registers. For the reduction of these evils, arising from supersaturated subsoils, the methods of subsoil drainage, by pumping for the whole of the metropolitan area, the lower tracts in the side of the covered area, and the subsoil drainage of the continuous uncovered area, the eastern and other low-lying marshy land was prepared for that land at a remunerative expense, and for the inside or covered area at an expense of about 9d. per annum per house for the extra pumping, the effect of which would be the same as if the whole site were elevated a number of feet. The engineering principle of the arrangement was similar to those in the Fen districts for sending the rainfall to the rivers, one sanitary effect of which was that where pounds of bark were formerly used, only ounces were now used against ague. They had no experience of fogs in dry weather or from soot alone, without moisture or damp, such as arose from supersaturated soils, an evil they had always with them. Richmond-park was once the seat of heavy fogs, from which it has been almost entirely relieved by drainage, and the health of the deer and cattle improved, and it would probably be relieved entirely, as also the other parks and open uncovered spaces, by a better system and work. The subsoil drainage of the site of Birkenhead had cleared away fogs there. At Liverpool, the reduction of damp, by the reduction of the supersaturation, by the reduction of the waste of water, is reported to have caused a material reduction of the death-rate. The measure for the removal of stagnant sewage and its evaporation, and sending the sewage, not to the river, but to the land, had been started by the German engineers, and was now in the course of successful application there. The next evil of which an examination had been entered into, but not carried very far, was the smoke nuisance. For this, the use of smokeless coal, such as anthracite coal, was indicated, and on this topic the National Health Society had entered into a very promising course of inquiry, for which public support was needed. The Society of Arts had conducted an inquiry some time ago for the award of a prize for new inventions of grates and ranges that consumed the least quantity of fuel; but it was found that the new inventions did not excel, and were often the same as old inventions which had never got into use; and they never got into extensive use at all, on account of the first expense of change. The compulsory measure advocated by Dr. Carpenter would be available as a motive for the purpose, but the Board of Health contemplated also the use of half-coked coal, which would have the quality of anthracite. They also contemplated the extended use of coal gas in houses for warming as well as cooking and lighting. This extension appeared to turn mainly on the reduction of the price of gas, and that by putting the supplies upon a public footing and public arrangements. The first obstruction to the extension of the use of gas apparatus, as well as new fire-places, was the selection and the cost of the apparatus for distribution into houses. For remedy, it was contemplated that the company, or the lighting authority, should substitute the apparatus and keep it in good action, for a rent, as was now done with gas meters, and, indeed, as had been done with great success in a provincial town for the whole apparatus. Instead of having to pay at once some six pounds, the occupier would only have to pay a rate of some six shillings a year, with the security of attention to the fittings. Measures could not be expected to be adopted without examination and preparation, and for examination and preparation a competent service must be appointed, provisionally, for the examination of the subject, which was more complex than might be supposed. But then it had to be determined what apparatus was the cheapest and the best. The chief gas company in London, for its own interest in the extension of the consumption of gas, would have promoted competition for the cheapest apparatus, but it was decided by the Board of Trade that they had no power to do so, and the Metropolitan Board of Works opposed their obtaining power. Power was also required to get the cheapest apparatus for cooking, and for warming and ventilating by gas, for warming by an apparatus that warms the pure air

which it pumps in, and removes the vitiated air. One thing is attendant on the introduction of gas into houses for warming—that there is a considerable reduction of the smoke, dust, and dirt within the house. One thing has not hitherto been attended to on this subject of the smoke nuisance, and that is, the washing bill, which may be reduced, under good conditions as to smoke consumption, and the washing bill for the metropolis may now be estimated at six millions. A reduction of this tax by one half by complete measures appeared to be practicable. Dr. Carpenter had talked of the amendments proposed, as requiring much money. Now when fully examined, it would be found that the measures, which were sound in sanitary principle, really saved money. If he (the Chairman) were now in office, with full executive powers, he would set aside his own particular measures, and the measures proposed by others of his time, and re-examine them, and prosecute the subject *de novo*. He agreed entirely with Dr. Carpenter's conclusion for the appointment of a Commission to examine the whole question, as the speediest means of obtaining efficient relief.

Mr. Robert Rawlinson, C.B., had listened with great pleasure to Dr. Carpenter's address, and agreed in the main with his proposals. He had explained the existence of fog in a very lucid manner. It did not always arise from vapour, but it did frequently, and in those cases, the removal of subsoil water by drainage would often abolish it. They knew that large areas were often covered with dense fogs in autumn and winter, but when these were drained, the fogs diminished. Every cubic foot of water removed, which would otherwise evaporate as vapour, allowed as much heat to remain as would raise two million cubic feet of air 1°; and when land was effectually drained it had been asserted that the mean temperature was permanently raised from 4° to 6°, and consequently it was equivalent to removing it a certain amount farther south. Dr. Carpenter had mentioned a fact which he also had often noted, though he had not understood it, viz., that fogs commenced with a very high barometer. One would have imagined that smoke would rise more readily in a dense atmosphere than in a light one, but it was not so. As soon as he saw the barometer begin to rise in autumn and winter, he knew he must expect a thick atmosphere. He did not think the remedy proposed, of imposing taxation on fireplaces, would be practicable. Englishmen were, very properly, irritable under taxation, and he thought the Legislature must find some other means of diminishing the consumption of coal and the production of smoke.

Mr. G. J. Symons, F.R.S., said this was the first time he had said anything about fogs, though he had studied their conditions for many years, having been all his life in a good position for such study. It was assumed that fogs were increasing, and were much worse than formerly, but he thought that was only another illustration of what was often found, that present evils always seemed bigger than past ones. We had just passed through half a dozen exceptionally wet years, and, consequently, the surface of the metropolis, which is yet undrained, had been in a wetter and colder condition than usual, and the result was to give an exceptional intensity to fog. He was quite prepared to say they had more fogs last year than usual, but as to their being very much worse, he doubted it. He would not occupy time by giving specimens of the fogs of bygone years, but he recollected some quite equal to anything we had had lately. Taking South Kensington for instance, he lived near there all the early part of his life, and his father went snipe shooting where Victoria Station now stood, and in that district, at that time, the fogs were quite as bad as they were now, though he was not prepared to say they were not whiter. There was no doubt that the carbon in the atmosphere did make the fog yellower, but he must leave it to medical men to settle how far that carbon was really injurious. He was rather sorry to hear the reference made once or twice to the magnetic condition of the atmosphere, for there was a tendency, whenever we did not understand anything, to hook it on to either electricity or magnetism. He would suggest that when we did not know, it was better to acknowledge our ignorance at once. He was not by any means charmed with the suggestion of referring this question to a Royal Commission; he had, unfortunately, been a member of two or three deputations lately to different branches of the Government, and, really, if they were to take up all the questions which were brought before them, and which they were expected to settle off-hand, he pitied them. He feared the appointment of a Royal Commission was rather the way to get a thing shelved; you got a wonderful Blue-book, which hardly anyone read, and, as a rule, nothing was done. He agreed with the remarks about gas fires; but in connection with them he had one grievance, which he believed was common to all who used them. He was quite sure the gas companies did not consult their own interests in giving such a low pressure during the daytime, the consequence of which was that when you wanted a good gas fire you could not get it, though in the evening, when the room was warm, you had a very good one. There could hardly be two opinions as to the advisability of gas companies turning their attention to the supply of gas for heating instead of lighting purposes; and he was glad to find, when at Exeter recently, that the gas companies there were thoroughly alive to the importance of this matter. With regard to the relation of fogs to barometrical pressure, it was generally known to meteorologists that fogs were found in the time of an anticyclone, which meant a heaping up of the barometer, just as a cyclone meant a diminution of pressure. Of course London, like other places, got a greater prevalence of fog when it got a greater prevalence of a high barometer, and they had an anticyclone of that character last year, and it was accompanied also by a low temperature. You must have low temperature and high pressure to get fog, and still more, you must have a cold state of the ground. Mr. Rawlinson was perfectly right in laying stress on the question of drainage, because the drainage and consequent warming of soil must diminish the amount of fog upon it. He would suggest the possibility that the very large amount of ground which had been built over, paved and drained, and recovered from its natural state, must perhaps, to some extent, have tended to keep the amount of fog constant; because while, on the one hand, there was more smoke from the habitations, on the other hand, there was a smaller area of evaporating surface. The only other remark he would make was one, showing that London was not alone in its complaints as to the increased prevalence of fogs. The anticyclones of last year prevailed over the whole north-west of Europe, and he heard from a Parisian friend the other day, that of late years they had had a very remarkable development of fog in Paris. After a very careful investigation, the Parisians came to the conclusion that they had had it ever since the Prussians came there.

Sir Francis Knowles F.R.S., said this was a most important subject, affecting not only the pockets of the people, but their health and the length of their lives. He wished to support, as far as possible, the conclusions to which Dr. Carpenter had arrived. An ordinary coal fire was generally left to burn rather low, then the door was opened, letting in a fierce current of cold air, and the housemaid piled on a heap of coal, which left all the inmates of the room in the discomfort of a glacial period until it burned up. He had made some calculations as to the result of the coal consumption in London, which were as follows:—The annual consumption might be taken at about 8,000,000 tons, or a daily consumption of 22,000. The ammoniacal liquor from bituminous coal was about

179 lbs. per ton, and deducting 13 lbs. for ammonia, it left about 166 pounds of watery vapour per ton of coal, or $16\frac{1}{2}$ gallons. In other words, there were 3,942,400 lbs. of ammoniacal liquor daily ejected into the atmosphere, with a due accompaniment of coal-tar and blacks. The injurious influence of this on the respiratory organs needed no proof, but prize cattle had been known under its influence. Turned into cubic feet, the watery vapour of this liquor amounted to 533,280 or 51,194,880 square feet, one-eighth inch in thickness, representing a most respectable daily rainfall. If that computation did not show what was the cause of fogs, he did not think anything would. The waste of this ammoniacal liquor was most serious. Our coal fields contained an enormous supply of nitrogenous matter, which, properly applied, would convert the whole of England into a garden; and from a calculation he had made, he estimated that the ammonia evolved from the combustion of coal in London alone was equal to the production of six million quarters of corn. Extending that to the whole country, would give some idea of the effect of this waste on our agricultural prosperity. Some time ago he tried an experiment with carburetted hydrogen from peat on red hematite ore, and, at the end of one hour and a quarter, when he drew the charge from the retort, he found mere charcoal at one side, and on the other the carburetted hydrogen had reduced the hematite almost to the condition of a metallic sponge. This showed how advantageous it would be partially to coke the coal, employing the gas in this way, before sending it to London for use in fire-places. There were two modes of avoiding the evil of fog, viz., using anhydrous coal, or anhydrous gas. In any smoke-consuming apparatus which might be devised, he would suggest, lastly, that it would be desirable to provide some means for condensing and utilising the ammonia.

Mr. Liggins thought the proper distinction to be kept in view was that between fogs and mists, the latter being created by nature, and the former by man. Then the question arose, was it possible to prevent London fogs. A great deal had been written in the papers on this subject lately, and one correspondent had stated that fogs were more frequent now than they used to be in the neighbourhood of Lord Holland's park than formerly, because that park was not drained. Now, he disagreed with that, because the greater portion of the park was on a hill and was therefore drained naturally. The ground in the neighbourhood of Kensington had been so covered with houses and roads that fogs there, and in the whole of the western suburbs, were nothing to what they were within his recollection. Fogs existed all over Europe; and he recollected about 30 years ago being in Paris, when the densest fog he had ever seen prevailed for an entire week. Only last week he read in the *Times* that ships were, for several days, unable to get into Havre, on account of the fog, and he had often been delayed and alarmed when coming up the English Channel by the same cause. He admitted the blackness of London fogs, but did not think they were as bad as they used to be; and as for the proposed remedies, he dissented entirely from Dr. Carpenter's conclusions. In the first place, the Home Sucretary would laugh at them, if they went to him and proposed that he should put down fogs by imposing a tax on fire-places, or by compelling people to burn gas, whether they liked it or not. Gas was an impossible fuel at present for general use, for many reasons. In the first place, the mains would not be large enough for the supply, and the companies would not be able to raise capital sufficient to relay the whole of London; on the chance of the public using it when supplied. He had had a gas-stove in his house for the last 22 years, but it was never used; and as for gas fires, most of those who had tried them knew that the heat they gave was a minimum quantity. There was also a great risk of smell, and danger from the great difficulty in getting good gas-fitters. They had quite enough gas explosions at present to render it very undesirable that the risk should be further increased. With regard to cannel and anthracite coal, they had been tried in ordinary ranges for forty years, and were a complete failure, except in the case of a very large fire, and then it required to be lighted and supplemented with ordinary coal. Then they were asked to stop the smoke that came from locomotives and steamboats. If Mr. Bramwell were there, he would tell them, that any one who could devise a means of doing so, would make a million of money; but the ingenuity of man had not yet succeeded in bringing forward an invention which would answer the purpose, and therefore it was useless to approach the Government with any such proposition.

Mr. Bamber then exhibited and described the grate, with a solid dead plate instead of the under grating beneath, which had been invented by Dr. Siemens for burning coke, thus preventing smoke. The fire burned only in front, where the heat could radiate into the room, the heat being withdrawn from the back, where it was of no use. This was effected by means of a copper back, which conducted the heat to the under portion, and through a copper frill work, which heated the air passing up by means of a vertical passage in front of the copper frill work, and a horizontal passage below the dead plate, into the front of the fire, where was an iron gas tube pierced with holes inclining upwards at an angle of 45°. Through this the gas passed, and served to light the fire, formed of coke or a mixture of coke and anthracite, after which the gas was partially turned down, but still served to keep the fire cheerful. Another and cheaper form of stove, was made entirely of cast iron. The cost in fuel was about the same, or rather less than that of an ordinary coal fire. The last speaker had said it would be impossible to supply sufficient gas for general heating purposes, but with this arrangement only a small quantity was required, about 12 cubic feet the first hour, and six or seven per hour afterwards, for a room half the size of that hall. Coke was rather a drug with the gas companies, and this would enable them to get rid of it, so that he had no doubt they would be glad to take it up.

Mr. Mitchell said the discussion seemed to have wandered into all sorts of subjects except the one specially brought before them, which was the causes of London fog and the means of getting rid of it. He hoped before the discussion closed, a little more light would be thrown upon these important questions.

A **Member** asked the cost of Dr. Siemens's grate, which he had inspected and was much pleased with. The ordinary asbestos gas fire he considered a mistake.

Mr. Bamber, in reply, said that the cost in cast iron, was 25s.; in copper, about two guineas.

Mr. Tracey, having protested against the Society being made an advertising medium, said, according to his experience, London fogs were no more dense than when he first remembered them. Again, London smoke was anything but an unmitigated evil, for it greatly neutralised the noxious effluvia arising from our present system of drainage. After a heavy shower the air in London was purer than in the neighbourhood of a country house, where the smell of the drains was always very prominent at such times.

Mr. G. M. Shore, after complimenting Dr. Carpenter on his paper, read a letter he had received from Mr. Deacon, engineer, of Cardiff, praising a furnace of his (Mr. Shore's) invention, a model of which was on the table. By means of this apparatus, the principle of which was a down draught and hollow fire bars, he warmed his entire house and a large conservatory with a fire-place $13\frac{1}{2}$ inches wide and 16 inches long.

Thorough ventilation without draught was easily obtained, and it could be adapted to coal mines, and prevent the sacrifice of human life.

Dr. Carpenter, in reply, said the discussion had been so discursive, that it was impossible to deal with the whole of it, and it was the less necessary to do so, as many of the points taken up were not strictly within the scope of the paper. The observations of Mr. Symons were very pertinent, and he agreed with him that the extension of the metropolis had reduced the amount of evaporation within the area. But the fogs which arise in connection with the moisture of the earth were not those which the meeting was convened to consider, as they were found everywhere. Great objections had been made to the proposal to put a tax on fire-places, as he had foreseen, and the appointment of a Royal Commission had also been objected to, but he still adhered to his opinion, that a subject of this difficulty would be better dealt with, in the quiet air of a committee-room of the House of Commons, than by any kind of discussion likely to take place in such an assembly as the present, where everyone had ideas of his own, not always based on scientific principles. Reference had been made by one speaker to coldness of the ground as a cause of fog, but he believed the soil of London was very much warmer than that of any other part of the British Empire; and it was possible that, instead of coldness, warmth might have something to do with it. He quite agreed with Mr. Symons that people often referred to magnetic influences when they were ignorant of a subject; he confessed his own ignorance, and he believed the majority of investigators were in a like position, though some might know much more about it than himself. He had, therefore, taken the liberty of introducing the reference to the magnetic state of the atmosphere as a thing worthy of consideration by those who were studying the subject. He hoped the suggestions he had thrown out would be the means of leading some of his hearers to think a little more about the subject than they had done hitherto, and to press it on the Legislature. He knew, from personal experience, and the records he had kept for many years, that fogs of this character were much more extensive, heavy, and frequent than they were 20 years ago, and extended to a greater distance from London.

On the motion of the **Chairman**, seconded by **Mr. Liggins**, a vote of thanks to Dr. Carpenter was passed.

CANTOR LECTURES.

Prof. A. H. Church, M.A., F.C.S., delivered the third lecture of his course of Cantor Lectures, on "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain," on Monday, 6th inst., in which he dealt with stoneware, and other wares, glazed with salt.

THE PHOTOPHONE.

In accordance with the notice given in last week's *Journal*, a selection of the more important diagrams used by Professor Bell in his paper are now published.

Figs. 1 and 2 show the form of selenium cell used by Werner Siemens; Fig. 1 shows the zig-zag

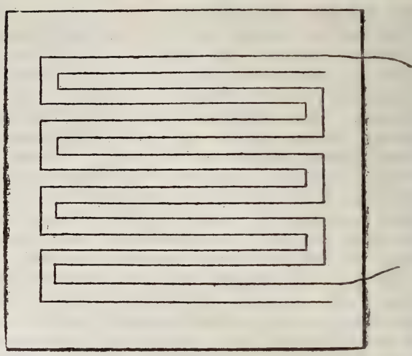


Fig. 1.

arrangement of the wires, and Fig. 2 the spiral.

Fig. 2.

Fig. 3 is the apparatus employed in annealing

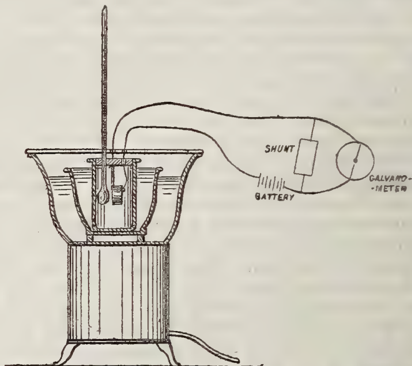


Fig. 3.

selenium cells by Professor Bell. The cell being placed in

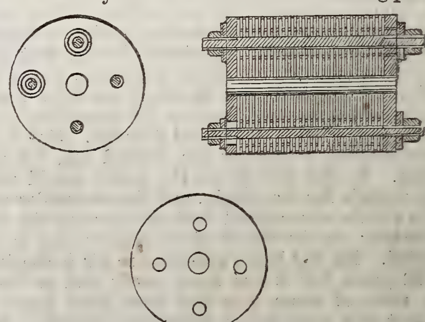


Fig. 4.

an interior vessel, and surrounded by outer vessels containing oil, a suitable source of heat is applied below the whole arrangement. Fig. 4 represents the latest form of selenium cell, in which alternate plates of brass and mica are placed on a central spindle, and held by screw bolts passing lengthways through the arrangement. The mica discs being slightly smaller than the brass discs, annular spaces are left, which can be

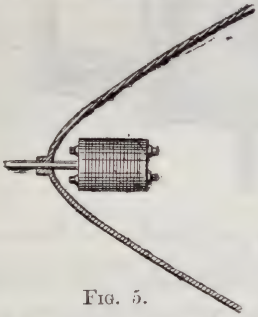


Fig. 5.

filled with selenium. Fig. 5 represents a cell of this description in the focus of a parabolic

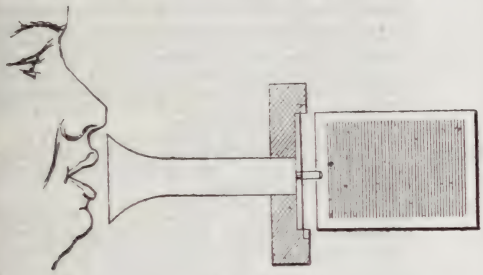


Fig. 6.

reflector. Fig. 6 shows one of the earlier forms of transmitter employed by Professor Bell, in which a grating is caused to vibrate over a fixed grating, by the impulses produced by the voice impinging on a thin diaphragm, fixed to the movable grating. Fig. 7 shows the whole arrangement for sending and receiving. A beam of light is reflected on a mirror, against the back of which the sender speaks. The rays reflected from this mirror pass through a lens, and are received at the distant station by the parabolic reflector, with the selenium cell as its focus. Fig. 8 and 9 show

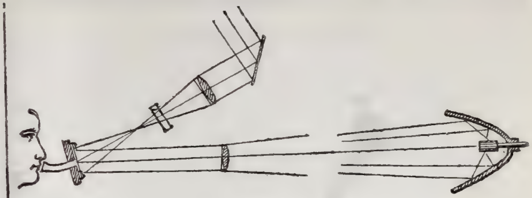


Fig. 7.

the arrangement adopted for producing a musical note

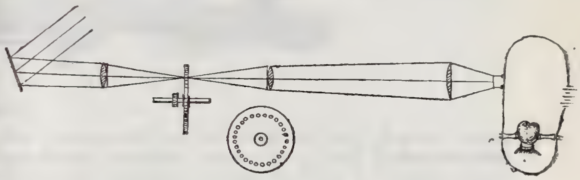


Fig. 8.

by rapid interruptions in the path of a beam of light.

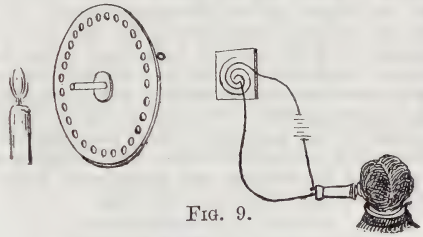


Fig. 9.

Fig. 10, together with the perspective view, Fig. 11,

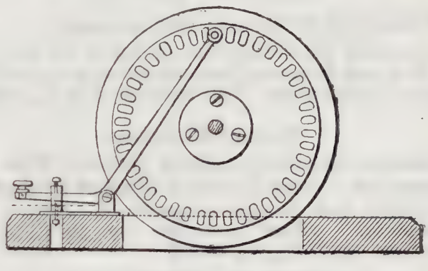


Fig. 10.

show the apparatus employed for this purpose. M is a

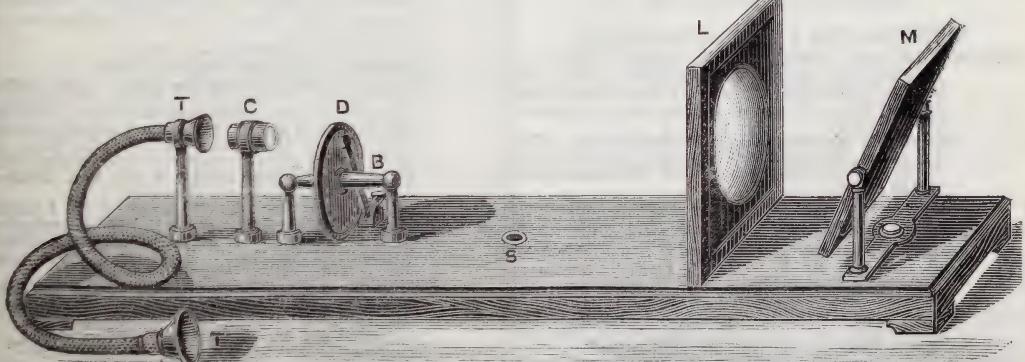


Fig. 11.

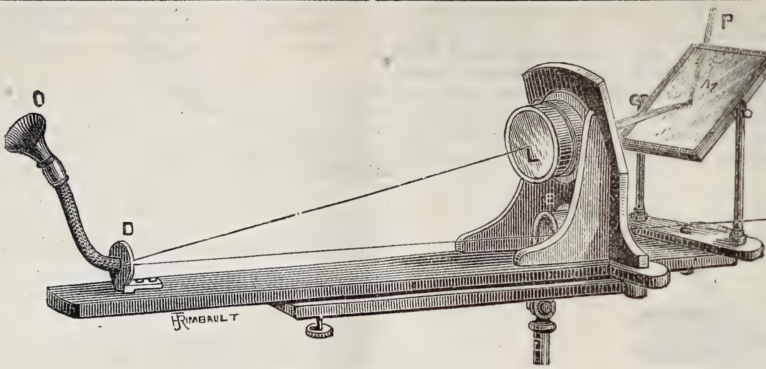


Fig. 12.

mirror for reflecting the light through the lens, L; D is the perforated disc; C is a lens, employed only when the apparatus is used to transmit signals, for which purpose the lever B becomes into play; T T is the hearing tube, at the mouth of which can be placed any substance to be tested for its power of producing sound under the impact of an interrupted beam. Fig. 12 shows the sending arrangement for the articulating telephone. M is the mirror; L the lens; D the flexible mirror or diaphragm; E the lens through which the light passes to the distant station; O is the mouthpiece of the speaking-tube. The two pieces of apparatus illustrated by the perspective views were exhibited by Professor Bell during his lecture. The blocks, by which the last two illustrations are reproduced, have been kindly lent by the editor of *Engineering*.

MEETINGS OF THE SOCIETY.

Ordinary Meeting.

Wednesday evening, at eight o'clock:—

December 15.—"The Use of Sound for Signals." By E. Price Edwards, Secretary to the Deputy-Master of the Trinity-house. Dr. Tyndall, F.R.S., will preside.

Cantor Lectures.

Monday Evenings, at eight o'clock. The First Course, on "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." Five Lectures, by Prof. A. H. Church, M.A. Oxon., F.C.S.

Lecture IV.—December 13.

Soft paste porcelains, European and Oriental.

Lecture V.—December 20.

Hard paste porcelains, Chinese, Japanese, and European.

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 13th ... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. A. H. Church, "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." (Lecture IV.)
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. A Discussion will be opened by Mr. Daniel Watney with a short paper, entitled "The Land Question in 1880."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Captain T. H. Holdich, "Geographical Results of the Afghan Campaign."
British Architects, 9, Conduit-street, W., 8 p.m. Mr. John E. Price and Mr. F. G. Hilton Price, "Remains of Roman Buildings at Brading, Isle of Wight."
Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. W. St. Chad Boscawen, "The Kings of the Hittites—their Unburied Monuments and Civilisation."

Tuesday, Dec. 14th...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. T. Seyrig, "The Different Modes of Erecting Iron Bridges."
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Photographic, 5a, Pall-mall East, S.W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m.
Zoological, 11, Hanover-square, W., 8½ p.m. 1. The Secretary, "Additions to the Society's Menagerie during the month of November." 2. Prof. T. H. Huxley, "The Application of the Laws of Evolution to the arrangement of the Vertebrata, and more particularly of the Mammalia." 3. Lieut.-Col. H. H. Godwin-Austen, "The Animal of *Ferussacia gronoviana*, Risso, from Mentone, concluding with a Classification of the above genus of Risso, and its Allies, by Geoffroy Neville." 4. Mr. Arthur G. Butler, "A Second Collection of Lepidoptera made in Formosa, by Mr. H. E. Hobson."
Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Sir Richard Temple, "The Statistics of the Indian Empire."
Royal Horticultural, South Kensington, S.W., 1 p.m.

Wednesday, Dec. 15th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. E. Price Edwards, "The Use of Sound for Signals."
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Rev. T. A. Preston, "Report on the Phenological Observations for 1880." 2. Mr. G. M. Whipple, "The Variations of Relative Humidity and Thermometric Dryness of the Air, with changes of Barometric Pressure at the Kew Observatory." 3. Mr. G. M. Whipple, "The relative frequency of given heights of the Barometer readings at the Kew Observatory during the ten years, 1870-79."
Geological, Burlington-house, W., 8 p.m. 1. Mr. John Arthur Phillips, "The Constitution and History of Grits and Sandstones." 2. Prof, P. Martin Duncan, "The Coralliferous Series of Sind, and its connection with the last Upheaval of Himalayas." 3. Mr. R. Etheridge, "A new Species of *Trigonia* from the Purbeck Beds of the Vale of Wardour." With a note on the strata by the Rev. W. R. Andrews.
Bankers' Institute (in the Theatre of the London Institution, Finsbury-circus, E.C.), 6 p.m. Mr. Robert William Barnett, "The effect of the Development of Banking Facilities upon the Circulation of the Country." Including (for the purposes of this inquiry) under the term "Circulation," Bank Notes, Country Bank Notes, Cheques and Bills. Being the prize essay for the present year.

Thursday, Dec. 16th...National Indian Association (at the House of the Society of Arts), 8 p.m. Sir Richard Temple, "The Effect of Western Education on the Natives of India."
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. Francis Darwin, "The Theory of the Growth of Cuttings:" illustrated by observations on the Bramble. 2. Lieut.-Col. H. Godwin Austen, "The Genus *Durgella*, and its Anatomy." 3. Mr. Francis Darwin, "The Means by which Leaves place themselves at Right Angles to the Direction of Incident Light." 4. Mr. Wm. Phillips, "A Revision of the Genus *Vibrissea*."
Chemical, Burlington-house, W., 8 p.m. 1. Mr. J. Ruffle, "The Estimation of Nitrogen by Combustion, including Nitro Compounds." 2. Dr. H. E. Armstrong, "Some Napthaline Derivatives." 3. Dr. H. E. Armstrong, "Some Hydrocarbons Present in Resin Spirit."
London Institution, Finsbury-circus, E.C., 7 p.m. Dr. Oliver J. Lodge, "The Relation between Electricity and Light."
Royal Historical, 22, Albemarle-street, W., 8 p.m.
Numismatic, 4, St. Martin's-place, W., 7 p.m.
Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Friday, Dec. 17th...Philological, University College, W.C., 8 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,465. VOL. XXIX.

FRIDAY, DECEMBER 17, 1880.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART-WORKMANSHIP.

I.

The Society's Medals in Gold, Silver, and Bronze, and Certificates of Merit, will be awarded for Specimens of Fine Art applied to Industry, exhibited in 1881, by manufacturers, designers, art-workmen, or possessors of such works.

II.

The works may consist of illustrations of any or all of the following processes, in combination or singly:—

1. Carving in marble, stone, or wood.
2. Repoussé work in any metal.
3. Hammered work in iron, brass, or copper.
4. Carving in ivory.
5. Chasing in bronze.
6. Etching and engraving on metal—Niello work.
7. Enamel painting on copper or gold.
8. Painting and modelling in pottery.
9. Decorative painting.
10. Inlays in wood (marquetry or buhl), ivory, or metal.
11. Cameo cutting.
12. Engraving on glass.
13. Wall mosaics.
14. Gem engraving.
15. Die-sinking.
16. Glass-blowing.
17. Bookbinding and leather work.
18. Embroidery.

III.

To all works the name of the designer and art-workman must be affixed. Further detailed rules will be issued later.

IV.

It is arranged with the Council of the Royal Albert Hall, that the place of exhibition for the above-mentioned works will be at the Royal Albert Hall. The time for sending in the works will be published hereafter.

V.

The above regulations are issued subject to modification.

JUVENILE LECTURES.

The usual short course of lectures, adapted for a juvenile audience, will be given by Mr. G. J. Romanes, F.R.S., on "Animal Intelligence."

The dates for the lectures will be Wednesday, 29th December, and Wednesday, 5th January.

The lectures will commence at seven o'clock. As in former years, admission will be by ticket only, and no member can be admitted without a ticket. A sufficient number of tickets to fill the room will be issued to members in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each member is entitled to a ticket admitting two children and one adult. All members who require tickets should apply at once, as the greater part of the tickets are now disposed of.

CANTOR LECTURES.

The fourth lecture of the first course was delivered on Monday, 13th inst., by Prof. A. H. Church, M.A., F.C.S., on "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." The lecturer dealt with soft paste porcelains, European and Oriental.

MUSICAL EDUCATION COMMITTEE.

A meeting of the Committee was held on Wednesday, 8th inst. Present—Sir Henry Cole, K.C.B., Vice-President of the Society (in the chair), Mr. Alan S. Cole, the Rev. Thomas Helmore, the Rev. Newton Price, Mr. James Thomson, and Mr. E. C. Tufnell, with Mr. H. T. Wood (secretary). A meeting was also held on Wednesday, 15th inst. Present—Sir Henry Cole (in the chair), Lord Alfred S. Churchill, Mr. Alan S. Cole, Rev. J. P. Faunthorpe, Mr. J. Thomson, and Mr. E. C. Tufnell, with Mr. H. T. Wood (secretary).

PRACTICAL EXAMINATIONS IN VOCAL AND INSTRUMENTAL MUSIC.

The next Examination in London will be held at the Society's House during the week commencing 10th of January, 1881.

The Examination will be held at three periods —morning, afternoon, and evening—viz., from 10 to 1, 2 to 5, and 7 to 10 o'clock on each day of Examination. Candidates may select either of these periods, but, the number of candidates in these Examinations being large, no special day or hour can be arranged for. The numbers

will therefore be arranged in order of application. The Examination for the Organ and Harmonium will be held in the evening only, and special arrangements will be made according to the number of applications. No alteration can possibly be made in this arrangement.

The fee is 10s. for the Honours (including both vocal and instrumental Examination), and 5s. for the First or Second Class (vocal or instrumental) Examination. If vocal as well as instrumental music, or two separate instruments, be taken by the same candidate for the First or Second Class Certificate, a fee of 7s. 6d. must be paid. Candidates should send the fee in stamps, or P.O.O. payable to H. T. Wood at the Head Office. As soon as the arrangements are completed, a numbered card will be forwarded, notifying the day and hour at which the candidate should attend, and the production of this card will admit to the Examination. The candidate will be known to the Examiner by this number only.

Candidates must also send a written certificate from some person qualified to give an opinion, to the effect that they have a reasonable chance of passing. Candidates who have already attended these examinations need not again comply with this regulation, but must state the fact.

At the conclusion of the Examination of candidates for the First or Second Class Certificates, the Examiner will record the result, with the marks in each section, on the back of the card, and hand the same to the candidate. The examination of the worked papers in the Honours Grade will necessitate some delay, but the result of this Examination will be conveyed to the candidates in due course.

The Certificates will be prepared as soon as possible after the Examinations, and can be had upon application at the House of the Society of Arts, on or after 1st March, 1881, on presentation of the numbered card. Certificates cannot be forwarded.

The Council will provide a grand piano, harmonium, and an organ. Any other instruments must be brought by the candidates. The services of an accompanyist will be obtained by the Society when candidates for singing are to be examined; candidates will, however, be permitted to bring their own accompanyist.

The Examination for the First or Second Grade Certificates will occupy about a quarter of an hour. Three hours and a half will be allowed for the Examination for Honours, during which time the candidates will have to undergo the *viva-voce* and the practical examination.

No Certificate will be granted to any candidate for Honours who does not obtain a First Class in the practical portion of the Examination, either vocal or instrumental. Candidates holding one of such Certificates, obtained in a former year, need not again undergo this portion of the Examination, but should bring their Certificate for the Examiner's inspection. In such cases three hours and a quarter only will be allowed to the candidate.

The Examination of each candidate will be private; no one but the Examiner and the accompanyist being present, unless it be a member of the Society of Arts' Committee. No list of candidates will be published.

Particulars will be forwarded on application to the Secretary, Society of Arts, John-street, Adelphi. No names can be received after 24th Dec., 1880.

PROCEEDINGS OF THE SOCIETY.

FIFTH ORDINARY MEETING.

Wednesday, December 15th, 1880; Prof. John Tyndall, LL.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Andrew, Capt. C. W., 286, Kennington-park-road. S.E.
Bayliss, Samuel, 5, Victoria-street, Westminster, S.W.
Browne, Miss Annie Leigh, 58, Porchester-terrace, W.
Johore, The Maharaja of, Singapore.
Keymer, H. J. C., Marine-cottage, Gorleston, and Gorleston-docks, Great Yarmouth.
Reid, Arthur G., M.D., 24, Montague-street, W.C.
Rigg, Arthur, 71, Warrington-crescent, Maida-vale, W.
Taylor, George Noble, 3, Clarendon-place, Hyde-pk., W.
Wiseman, William Percival, Cumberland-house, West Pennard, Glastonbury.
Wragge, Clement Lindley, F.R.G.S., Farley, near Cheadle, Staffordshire, and Adelaide, South Australia,

The following candidates were balloted for, and duly elected members of the Society:—

Begley, Mrs., 26, St. Peter's-square, Hammersmith, W.
Fall, Thomas, 9 and 10, Baker-street, Portman-sq., W.
Fisher, Thomas, Church Entry, 75, Carter-lane, E.C.
Horsman, Godfrey Charles, 22, King-street, Portman-square, W.
Macauley, Lieut.-Colonel George William, 43, Craven-road, W.
Stubs, Peter, Statham-lodge, Warrington.
Symmons, Edmund, Eagle-house, Hermon-hill, Woodford.
Walker, Robert, J.P., Kidwells park, Maidenhead.
Waterhouse, Sebastian, 37, Catherine street, Liverpool, and Windham Club, S.W.
Willans, William Henry, 23, Holland-park, W.

The paper read was on—

SIGNALLING BY MEANS OF SOUND.

By E. Price-Edwards.

In a recent trial it was argued that the transmission of verbal sounds, *i.e.*, of the sounds

produced by articulate speech, should properly be regarded as signalling, but in connection with the observations which I shall offer to you this evening, I prefer to accept the view of the learned counsel on the other side, and to avail myself of his retort to the effect that, although my remarks are in a sense transmitted to distant hearers in this room, yet it would be an obvious misapplication of terms to say I was signalling to those hearers. I think it necessary to make this preliminary observation, because it is beyond my purpose on this occasion to deal with those methods of conveying oral sounds which have been so marvellously developed during the last few years. The value to mankind of these astonishing discoveries cannot yet be fully apprehended. We are evidently on the threshold of great changes, as regards means of carrying messages; the steam locomotive, the penny post, even the telegraph system itself, are threatened by the possibility of other more simple and direct methods being brought into practical operation, by means of the telephone, the phonograph, the microphone, and last, but by no means least, the photophone, of which so brilliant a description was recently given in this room by its talented discoverer.

But these are not the instruments which minister to the practice of signalling, in the sense in which I desire to place it before you.

A signal is defined as a sign which has been agreed upon to give notice of some occurrence, command, or warning, to a person or persons at a distance. The necessity for such means of conveying intimations is too obvious to be dwelt upon. I need hardly recall to you the system of signalling by beacon fires, which was so extensively in use in early days; nor need I remind you that those crude methods of ancient times have, in the process of time, been generally superseded by simpler and more effective means. The splendid lighthouses on our coast, which convey guiding and warning signals to the mariner; the coloured and other lights used for vessels at sea, and also for railway purposes; flashing signals, employed for communicating between H.M. ships at night, and for other purposes, are all suggestive of ancient practice, although more elaborate and perfect, and suited to modern requirements.

Flags, again, have for centuries been used as emblems and signals for the conveyance of messages across intervening spaces. For military purposes they continue to be used, and for service at sea they have been so effectively utilised that there now exists an international code, generally adopted by all maritime nations, which permits conversation to be carried on between ships of all countries, the combinations of eighteen flags and three pennants being the signals whereby messages pass between mariners who do not even understand each other's language.

The semaphore was once much used for military signalling, but it is now almost entirely employed in connection with the railway service.

For storm warnings, drum and cone shapes are hoisted at prominent points on the coast, to indicate the approach of bad weather.

And I may allude to the valuable invention of the heliograph, or sun-flashing mirror, which rendered such conspicuous service in the late wars in Afghanistan and South Africa, by which signals can be flashed across an intervening space of from 50 to 100 miles.

Finally, signals of distress are made on board ship by the firing of rockets, and by flames on the deck.

It will be observed that the examples of signalling to which I have alluded are those which appeal to the sense of sight only. Signals, being intended for human purposes, are, of course, dependent upon human perceptions for their comprehension. Sight, as we have seen, is made available. I do not think any definite system has been developed by which signals can be transmitted through the medium of taste or touch; nor has science yet indicated any method of utilising the sense of smell for the conveyance of definite messages, although, in the vicinity of foul places and decomposing refuse, odoriferous signals are generally wafted abroad, plainly indicating the presence of germ-laden gases, and silently bidding us beware.

But the necessity for transmitting signals has been found to exist at times when sight is unavailing, and then the sense of hearing naturally suggested itself as the perception which should be appealed to.

Thus we arrive at the branch of the subject which I have ventured to bring under the notice of the members of the Society of Arts this evening; and I think it proper to say, that in preparing this paper, I have sought rather to make it a record of facts than anything like a speculative inquiry, and have encouraged myself to hope that my efforts may possibly be the means of bringing to bear upon the subject the scientific and mechanical intelligence of many, in such an audience as this, and who may assist in the valuable work of developing the means of making sound signals fulfil their purposes with accuracy and precision.

The effective employment of sound-signals appears to be chiefly dependent upon two factors, the facilities offered by the atmosphere as a vehicle of sound, and the human capacity for hearing and distinguishing sounds of different characters. It will, perhaps, be convenient to regard first these two points, and afterwards to deal with the application of sound signalling for various purposes, and the different kinds of instruments used to produce the sounds.

It is hardly necessary, before such an audience as this, to attempt an explanation of the general laws governing the propagation of sound; and, in the presence of so eminent an authority as the learned professor who has so highly honoured my subject and myself by presiding this evening, to do so would show some temerity on my part. It is, nevertheless, necessary for me to put before you briefly various considerations relating to sound transmission, which have a direct bearing upon the matter in hand, but it is only proper for me to observe that in this respect I must borrow the thunder of your learned chairman, and place before you results obtained through his patient investigation, judicial weighing of evidence amid conflicting theories, and unstinted expenditure of time and personal comfort.

The atmosphere is the vehicle for transmission of sound with which we are this evening concerned. Water is an excellent medium for sound travelling, and the possibilities which have from time to time

been suggested in regard to it, require only the attention of inventive genius to bring them within the range of practical reality and utility. But as at present the atmosphere is the only medium which is practically available for the transmission of sound signals, it becomes important to know whether some conditions are more favourable than others for its passage.

It is evident that there are various influences which may be supposed, in one way or another, to affect the transmission of sound. Wind has always been known as a most powerful agent in intercepting and even diverting it. Fog, snow, and rain, have also been regarded by many as serious obstructions, while it has long been popularly considered that a bright, warm, sunshiny day, with little or no wind, was exceptionally favourable for the travelling of sound. These views, it may be said, have grown up as the result of general expectation rather than of scientific observation; but the development of signalling by means of sound has necessitated a more exact inquiry, than has hitherto been made, into the general subject of sound transmission, and the result has been that some of the old theories have been considerably shaken, if not overthrown, while new ones have been set up.

In the years 1873 and 1874, an investigation was carried out, at the instance of the Trinity House, with the object of obtaining some definite information as to the relative merits of sound-producing instruments, and also of ascertaining how the propagation of sound was affected by different meteorological phenomena. Professor Tyndall, as the scientific adviser of the Trinity House, conducted the investigation, aided by a Committee of the Elder Brethren, and some officers of the Corporation. The experiments were extended over a lengthened period, observations being made in all conditions of weather, and repeated over and over again, in order to eliminate error; and the information gained thereby is of the highest interest and importance.

The results are stated at length in the third edition of Dr. Tyndall's book on "Sound," but may be popularly summarised as follows:—That neither rain, hail, snow, or fog, has any sensible power to obstruct sound. From this it is most satisfactory to know that, at those times when a sound signal might especially be of service, the sound is not likely to be obstructed in its passage. That the real obstructors of sound are—first, the wind; and, secondly, what Dr. Tyndall has named acoustic clouds. These clouds have nothing to do with ordinary clouds, fogs, or haze, and may arise from air currents differently heated, or from air currents differently saturated with vapour, and they often exist on days when the atmosphere is in a very transparent condition. The obstruction is caused by the sound, intercepted by the acoustic clouds, being wasted by repeated reflections. In short, it is now established that a bright clear day is not necessarily the best for hearing distant sounds, and that on a day of dense fog it is more than probable that no obstruction is offered to the passage of sounds.

I must not omit to mention that experiments of an elaborate nature, in respect to the propagation of sound in the atmosphere, have also been made under the auspices of the United States Lighthouse Board, with results mainly corroborating those obtained in the Trinity House trials. In one respect, however, the late Professor Henry, who was at the time Chairman of the United States Lighthouse Board, differed from Dr. Tyndall, viz., in regard to the theory of acoustic clouds, and their resultant aerial echoes. Professor Henry's explanation of the obstruction of sound in clear weather, and the echoes, is founded upon the asserted existence of upper and lower currents of air, the tilting up of the sound wave, and the reflection of the sound from the surface of the sea, or the crests of the waves. From this last explanation, Professor Henry seems to have receded before his death. Into the details of this purely scientific controversy, it is not necessary to enter; but it may be stated, as a matter of fact, that the observations at the South Foreland, and the explanations given of them by Professor Tyndall, have been, one and all, illustrated and confirmed by strict experiment.

One other point may appropriately be alluded to here, viz.—as to the nature of the sound which is most readily propagated through the air, and which, therefore, is most effective for signalling purposes. It appears that what Mr. Alexander Beazeley (who very ably treated this subject of coast fog-signals some years ago) has termed "effective sound range," is made up of two factors, viz., intensity and pitch. It is tolerably well established that initial intensity is the first thing needful, and initial intensity depends upon the actual force employed in creating the sound waves. With suitable apparatus, and an effective application of very high power, there is little doubt that sounds of overpowering loudness may be produced. But the effective range of sound appears to be also controlled by its musical pitch. The short waves of a very shrill or high-pitched sound may appear extremely powerful and effective to observers in the immediate vicinity, but their energy seems to be quickly dissipated, and the sound fails to be appreciated effectively at a distance. Again, the long undulations of a very low-pitched sound do not apparently often reach great distances. It may be that this kind of movement is more readily acted upon by opposing influences, such as reflection or diversion. But, for practical purposes, it seems that the pitch best adapted for signalling lies about the middle of the scale of sound. With sound, as with light, there are wave motions above the highest pitch intelligible to the human ear, and below the lowest sound audible, and it may be, that the nearer sounds approach the limits of human apprehension, so they tend to become less appreciable. In addition to this, it has been found that the atmosphere exercises a selective influence, and, within certain limits, will, under some conditions, favour the transmission of the shorter waves, or high-pitched note; while, at another time, it may be found that the longer waves of a low-pitched note have the advantage.

Speaking generally, the range of sound seems to be attended with much uncertainty. It is popularly supposed that if a sound, at any one time, is heard ten or fifteen miles, it must necessarily be an exceedingly powerful sound. Now, this does not follow as a matter of course. The variability of the atmosphere will throw out any

calculation made upon such an hypothesis. In the experiments at South Foreland, in calm, clear weather, one of the instruments was, on a certain day, heard at a distance of 16½ miles, but on another day, with apparently identical weather, the same instrument was heard at only 2½ miles distance. Obviously, it is no satisfactory test of a good signal that on one occasion it had a great range—sounds comparatively small and weak have at times been audible at long distances—and, therefore, I need not trouble you now with instances of this kind. The true test of a sound signal appears to be that it shall, under all conditions of weather, be uniformly effective at a short distance—say two miles.

I referred just now to what, perhaps, I may speak of as the sound spectrum, and to the limits of human capacity in regard to hearing sounds. Now, with the development of signalling by means of sound, I am not sure that the human capacity for hearing and distinguishing sounds of different kinds has received the consideration which it merits. Let it be granted that you have instruments capable of producing sounds of great power; let it also be granted that the signals appear to be distinctive and easy of comprehension, you will, I fear, still find very many people in the world incapable of availing themselves of such signals, either by reason of whole or partial deafness, or inability to appreciate differences in sounds. Now, the question almost naturally asserts itself, cannot something be done to assist the ear, or, at any rate, the perception of sounds in the air. This seems to be the complementary side of the general question, to which but little attention has been given. In regard to visibility, you have telescopes and binocular glasses, by means of which a distant object can be brought more plainly into view. But nothing of any real value has been done to assist the hearing. The old-fashioned ear-trumpet for deaf people is little, if at all, improved. Some years ago, an effort was made in this direction by a gentleman from Glasgow, who devised what he termed a phonoscope. This instrument consisted of a sort of metal helmet for the head, with an opening like the bent cowl of a chimney, which could be directed towards any point required. This cowl was supposed to act as a sort of ingatherer of sounds, which were conveyed to the ears by two small tubes, each terminating in a button, intended to go just inside the ear. The faults of this apparatus were, first, its cumbrousness, and, secondly, the remarkable way in which all the ordinary small noises around were collected and magnified into large ones, which, combined with other sounds hitherto unheard, created a general uproar in the ears. The object this gentleman had in view deserved greater success than it obtained. He wished to assist the mariner in picking up and locating a distant sound; and, although his apparatus acted so well that it picked up noises of all kinds, and somewhat bewildered the sense of audition, yet I venture to say that if any one were to accomplish successfully what this gentleman so perseveringly attempted, a very great public benefit would be brought about. I do not mean to convey that what is specially wanted is an improved ear-trumpet for deaf persons, but, rather, an instrument intended to aid people with fair hearing, or to render sounds, in some way, more easily perceptible. The late Professor Henry, of Washington, in carrying out his experiments, devised what he termed an artificial ear, by which the relative power of different sounds could be determined at short distances. This instrument consisted of an arrangement by which sand, on a stretched membrane, assumed certain definite forms, or was more or less agitated, in response to different sounds. As a phonometer, at short distances, this instrument appears to have been fairly effective, but it does not meet the want which appears to me to exist. With the growing use of sound for various purposes, there is scope for inventive genius to produce a phonoscope, which shall be capable of assisting the listening ear in a manner analogous to that by which a telescope aids the seeing eye.

The following is a general statement of the chief purposes for which sound signals of different kinds are in practical operation:—

1. *Railways.*—Whistles of locomotives, and explosives as fog signals.

2. *At Sea.*—For merchant ships, the international regulations for preventing collisions at sea prescribe, as a compulsory requirement, that in fog, mist, or falling snow, whether by day or night, the signals described as follows, shall be used:—

(*a.*) A steamship, under way, shall make, with her steam whistle, or other steam sound-signal, at intervals of not more than two minutes, a prolonged blast.

(*b.*) A sailing ship, under way, shall make, with her fog-horn, at intervals of not more than two minutes, when on the starboard tack, one blast; when on the port tack, two blasts in succession; and when with the wind abaft the beam, three blasts in succession.

(*c.*) A steamship and a sailing ship, when not under way, shall, at intervals of not more than two minutes, ring the bell.

And, as an optional proceeding, that a steamship, under way, may indicate her course to any other ship which she has in sight, by the following signals on her steam whistle, viz., one short blast to mean, "I am directing my course to starboard." Two short blasts to mean, "I am directing my course to port." Three short blasts to mean, "I am going full speed astern." A gun fired at intervals of about a minute is one of the authorised signals of distress at sea. In the Royal Navy the above regulations are also in force, but, in addition, Captain Colomb's system of sound-signalling is employed in fog, for the purpose of communicating between H.M. ships. Guns were formerly in use as fog signals, but are seldom if ever employed now.

3. *The Army.*—The only sound signals systematically employed appear to be those made with the bugle.

4. *Coast Fog Signals.*—By far the most important development of sound signals is in connection with the lighthouse and coast-marking service. The most powerful lights are unavailing at night if enshrouded with fog, and, by day, buoys, beacons, and other marks and signs of the sea, are then rendered useless. The necessity for sound signals to do duty at such times for the obscured lights and hidden sea-marks, has brought

about the development of a system of coast fog signals, in which development, so far as the English coast is concerned, the Corporation which I have the honour to serve, aided by your distinguished chairman, Mr. James N. Douglass, the Trinity House engineer, and others, have had a large share. The Commissioners for Lighthouses in Scotland and Ireland, aided by their respective engineers, have also taken vigorous measures for guarding their coasts with fog signals when necessary. It is proper, however, to observe that the lighthouse authorities in the United States took up the matter practically before it engaged much consideration in this country, owing to the east coast of America being in an exceptional degree liable to the visitation of fog, by which the coasting traffic was seriously inconvenienced; and the necessity arose for something to be done whereby the difficulty might be obviated. The ready genius of the country was not long in coming to conclusions, and although some kinds of sound signals, such as bells, gongs, &c., were employed in Europe, the Americans first brought into use Brobdignagian trumpets, whistles, &c., to which I shall refer in due course.

We will now pass on to consider the different kinds of instruments employed in connection with the various purposes to which I have referred.

Bells.—Bells, from the earliest times, have been employed to convey intimations by means of sound. Their chief uses in olden times have been summed up in the following :—

> "Laudo Deum verum, plebem voco, congrego clerum,
> Defunctos ploro, pestem fugo, festa decoro."

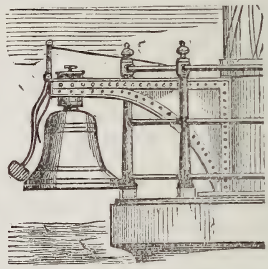
In these days churches have not a monopoly in regard to the use of bells. The town-crier, the muffin-seller, the railway-porter, and many others signalise themselves by the ringing of bells. With these, however, we are not concerned, unless we may express an opinion that in some of these cases it would be an addition to the public comfort if they were suppressed.

The present regulations for preventing collisions at sea require that, in fog, mist, or falling snow, "a steam-ship and a sailing-ship, when not under way, shall, at intervals of not more than two minutes, ring the bell." These regulations are international, but the Turkish Government have objected to the use of bells as fog signals on board Turkish vessels, on the ground that it is against their religion to use bells on board ship; and, therefore, in all cases where the regulations require a bell to be used, a drum will be substituted on board Turkish vessels.

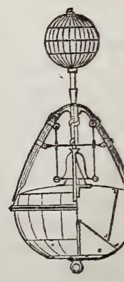
As warning signals, bells have been employed from a very early date. It is impossible to say when, or where, the first bell was put up to assist mariners; but we may quote the often-narrated tradition, handed down by an old writer, respecting the Bell Rock :—

> "By east of the Isle of May, twelve miles from all land, in the German Ocean, lyes a great hidden rock, called Inch Cape, very dangerous for navigators, because it overflowed every tide. It is reported in old times upon the saide rock there was a bell, fixed upon a tree or timber, which rang continually, being moved by the sea, giving notice to the saylers of the danger. This bell, or clocke, was put there and maintained by the Abbot of Aberbrothock; and, being taken down by a sea pirate, a yeare thereafter he perished upon the same rock, with ship and goodes, in the righteous judgment of God."

The story, it is true, is only supported by tradition, but it serves to show that the notion of marking a hidden danger by a sounding bell was certainly in existence—if not practically applied—at a very early period. We know it was practically applied at Poolbeg, in Ireland, in 1811, and at the Bell Rock, in Scotland, in 1812; and we also know that, up to the year 1860, bells were established, to be sounded in foggy weather, at many other lighthouses on the coasts of Great Britain and Ireland, and of France, the United States, and other countries, many of which continue to be sounded at the present day. These bells vary in weight



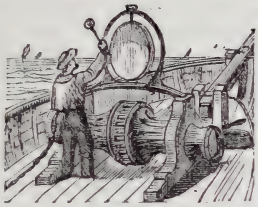
from 3 cwt. to 45 cwt., and are generally struck by means of clockwork. In no case does the bell itself move, the clapper, or clappers, alone being actuated by the machinery. It is well known that the sound of a bell is curiously fluctuating. In the open country or at sea, in the neighbourhood of church bells, the sound may be heard rising and falling, the peal swelling out as if close at hand—now fading into the thinnest sound, as if retreating far, far away. These effects are familiar to most people, and in themselves are really beautiful; but they come into play injuriously when the sound is wanted to be evenly distributed over a certain area. The truth probably is, that the vibrations from the largest bell are not of sufficient intensity to yield a sound capable of overcoming opposing influences, even of a slight nature. The sound produced in the immediate vicinity of the bell seems, no doubt, exceedingly powerful, the greatest energy of vibration being there exerted; but, at moderately long distances, this apparent energy is dissipated, and the bell ceases to be of use. It will be easily understood that little dependence can be placed upon bells as trustworthy sound signals for long distances. The effective sound range of the largest bell is at all times very doubtful; the wind may carry it to a distance even of 10 or 12 miles, but against the wind it may be inaudible at less than a quarter of a mile.



In one form the bell continues to be serviceably employed, viz., when fixed on the top of a large

buoy, with four hanging clappers around the outside of the bell, which alternately strike the bell as the buoy is moved from side to side by the action of the waves. An incessant tolling is thus kept up; and at night, or in foggy weather, the signal is most useful to mark the turning points at the entrances to important ports, and at other places where the navigation is intricate, or to mark isolated dangers. The number of bell buoys round the British coast is considerable.

Gongs.—The next kind of sound-producer we have to notice is the gong. To most of us, probably, the gong has an inviting sound, that is, as used for signalling purposes in our households. This instrument has been appropriated for use on board the light-vessels round the coasts, owing, probably, to its peculiar distinctive sound. The gongs used in the Trinity House service are about two feet in diameter, of Chinese make, and cost



about £4 each. They are struck with a stick with a padded head, the strokes being very short, and delivered in quick succession, so as to bring up the gong into a vigorous state of vibration. The sound is undoubtedly distinctive, and serviceable at very short distances; but, like the sound of a bell, is soon dissipated after leaving the immediate vicinity of the instrument. Passing vessels may approach nearer to a lightship than to a rocky coast marked by a lighthouse; therefore, a sound with only a short range may oftentimes be of great service. In many lightships, however, the gong as a fog-signal is now superseded by instruments of very much greater power.

Guns and Explosive Signals.—Guns are used for various purposes in connection with signalling. "The minute gun at sea," indicates that some vessel is in distress, and that assistance is required. This is one of the authorised distress signals. On board H.M. ships, guns have been employed for signalling in foggy weather, in accordance with an arranged code; and for salutes and other announcements, they are used at military depôts and elsewhere. But their chief service has been as warning signals on headlands and dangerous points on a coast, to assist the mariner in foggy weather. The necessity for distinctiveness in the use of sound signals, and the loudness of the report yielded by the discharge of cannon, led to the adoption of this form of sound producer.

There is no doubt that these gun signals have been of the greatest value. Many and many a time the warning gun has been heard by the bewildered seaman in time to enable him to alter his course, and probably save his vessel. Formerly the guns were fired every fifteen minutes, but recently the interval has been altered to ten minutes. It would be difficult for two men to clean, load, and fire, for a lengthened period—say even twelve hours—with less intervals than ten minutes between each discharge.

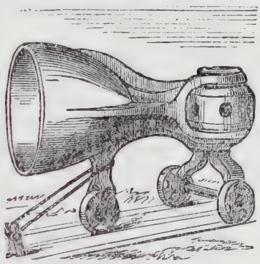
The piece of ordnance ordinarily employed was the old long 18-pounder, with a 3-lb. charge of powder; but in the Trinity House experiments at the South Foreland, it was found that a short gun, the 24-lb howitzer, gave a better sound than the long 18-pounder.

Professor Tyndall thus sums up his opinion of the gun as a fog signal:—

"The duration of the sound is so short, that, unless the observer is prepared beforehand, the sound, through lack of attention, rather than through its own powerlessness, is liable to be unheard. Its liability to be quenched by a local sound is so great, that it is sometimes obliterated by a puff of wind taking possession of the ears at the time of its arrival. Its liability to be quenched by an opposing wind, so as to be practically useless at a very short distance to windward, is very remarkable."

Professor Tyndall continues:—"Still, notwithstanding these drawbacks, I think the gun is entitled to rank as a first-class signal."

In 1874–76, some experiments were made at Woolwich Arsenal, with the view of reducing the labour of firing, so as to enable two men to fire at more frequent intervals, and also to produce, if possible, a more effective report than had been obtained by discharges from guns of ordinary pattern. Colonel Eardley Maitland, of the Royal Gun Factories, Woolwich Arsenal, devised a form of gun, breechloading, with six chambers, similar, in some respects, to a revolver, and with a parabolic mouthpiece fitted to the muzzle. The experiments gave promise that this fog signal gun would prove



a success, and ultimately it was conveyed to the North Stack, near Holyhead, in order that it might have a practical trial. To reach the station, it was necessary to cross very bad mountain roads, and the gun received a severe jolting, and probably jarring, for it broke down shortly after being used. No further attempt was subsequently made to repair the damaged gun, nor to manufacture another, owing to the attention of the Trinity House being then diverted to gun-cotton as an explosive sound-producer. It should also be mentioned that, in the trials at Woolwich, one experiment was devoted to testing the comparative advantages of the various kinds of service powder for noise-making purposes. The powders tested were—(1), F. G. (fine grain); (2), L. G. (large grain); (3), R. L. G. (rifle large grain); and (4), P. (pebble). In point of effectiveness in sound-producing, the result of the trial placed the powders exactly in the order in which I named

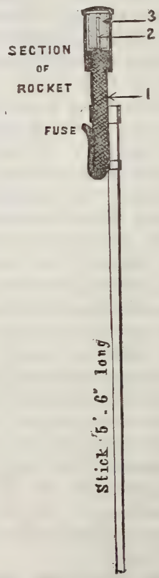
them; the fine grain, or most rapidly burning powder, giving indisputably the loudest sound; while the report of the slowly burning pebble powder was the weakest of all. The 80 and 100 ton guns, fired with charges of 300 and 400 lbs. of pebble powder, do not make anything like so terrible a noise as the enormous charge would lead one to expect. The sound seems to lack intensity; and, in comparison with the sharp smack of the detonation of gun-cotton, or of a much smaller charge of more rapidly burning powder, appears to be more of a prolonged and somewhat soft roar.

While upon the subject of guns, I must not omit to refer to the very ingenious invention of the gas gun by Mr. J. R. Wigham, of Dublin, the advantages claimed for which are that, where a supply of gas is available, the apparatus is very easily applied, and that the gun can be loaded and fired at a considerable distance from the point of explosion. The gun consists merely of a tube about 18 inches bore and 12 feet long, placed at the point where the signal is required to be made, and connected with a gas main or gas-holder, by iron piping. The gun is loaded with an explosive mixture of gas and atmospheric air, by turning on a cock simply, and is fired by a light applied by percussion or otherwise to the shore end of the tube, the explosion taking place at the mouth of the gun almost immediately. Mr. Wigham states that a gas gun may be fixed at the water's edge, or on a rock in the sea, at half a mile from the loading and firing station. The idea, which is certainly one of originality, was conceived by Mr. Wigham when he was engaged in connection with the application of gas to the lighthouse at Howth Bailey, and his experiments at that station have met with a very encouraging amount of success, but the system is not yet in practical operation as a fog signal.

In 1874, the Trinity House obtained the consent of the War Department to some experiments being made at the Royal Arsenal, with the object of ascertaining the value of the sound produced by the explosion of varying quantities of gun-cotton. The explosion of gun-cotton takes place so instantaneously, that an exceedingly sudden and sharp blow is given to the surrounding air, whereby a sound wave of great initial intensity is generated. A number of comparative trials were made at Woolwich and elsewhere, in which the superiority of gun-cotton over gunpowder was incontestably demonstrated. It was found that charges of gun-cotton, however fired, yielded reports louder at all ranges than equal charges of gunpowder; and further experiments proved that the detonation of half a-pound of gun-cotton gave a result at least equal to that produced by the firing of a 3-lb. charge of gunpowder. During these experiments, the various charges of gun-cotton had been merely suspended from a horizontal bar, or in the focus of a large parabolic reflector, and fired by means of electricity. To explode gun-cotton, it is necessary to employ a detonator, consisting of a small cylindrical copper case, resembling an elongated percussion cap, containing a certain quantity of fulminate of mercury. This detonator is inserted in the heart of the portion of gun-cotton to be exploded, and an attachment is then made with one wire, connected with a small electric machine, and with another attached to a conducting-plate embedded in the earth. On turning the handle of the machine, a current is induced sufficiently strong to generate a spark at the connection of the wires with the detonator, which, coming in contact with the fulminate of mercury, immediately explodes it, and instantaneously the explosion is communicated to the gun-cotton. If gun-cotton in a wet state is used, it is necessary to have a small plug or primer of gun-cotton, into which the detonator is inserted. Four processes then take place, viz.:—1. Generation of electric spark. 2. Ignition of detonator. 3. Communication of explosion to dry primer. 4. Communication of explosion of dry primer to the wet portion. The entire operation is, however, perceptible to the human sense as one explosion only. It will be readily understood that to discharge gun-cotton in this way entailed some little expenditure of time and trouble, and might prove inconvenient, if required to be repeated every ten minutes for many hours during fog.

But it being clearly demonstrated that the explosion of gun-cotton gave a very effective sound, a project emanated from the Deputy-Master of the Trinity House (Admiral Sir Richard Collinson, K.C.B.), for making a rocket serviceable for carrying a charge of gun-cotton up to a certain height, and then causing it to explode. This project was, with the aid of Mr. Brock, the well-known pyrotechnist, and, subsequently, Mr. Mackie, and the officers of the Woolwich Arsenal, after numerous experiments, made a practical success; and now, at five stations on our coasts, we have sound rockets, either substituted for guns previously used, or established *de novo* for signalling in foggy weather.

The following description of the rocket now used



is given in the instructions issued to the fog signal attendants at Flamborough-head, where sound rockets have been in use since January, 1878. The explosive used is a slight modification of gun-cotton, called tonite, which is said to be cheaper than ordinary gun-cotton, and as effective for producing a loud report.

DESCRIPTION OF ROCKETS.—For purposes of safety, the rocket is supplied, and is to be kept, in three parts, viz.:—

(1.) *The Rocket.*—This is a case charged with the ordinary rocket composition, and is intended merely to carry up the explosive charge to the required height, and then to ignite the detonator which is to explode the tonite.

(2.) *The Detonator.*—This is an enlarged percussion-cap, filled with fulminate. Its duty is to cause an explosion to take place in the heart of the tonite charge, whereby that charge is exploded. The detonator is ignited by the burning of the rocket composition.

(3.) *The Tonite Cartridge.*—This is the explosive which produces the report, and which, with the detonator placed inside it, is to be fitted in the head of the rocket, when immediately required for use."

The fitting together of the three parts can be accomplished in less than a minute; the rocket is then lighted by applying an ordinary fusee to a piece of Bickford fuse, communicating with the rocket composition. The whole operation occupies less than two minutes. The cost of the rocket is about 1s. 5d., whereas each discharge of the gun costs 2s.; and in foggy weather a rocket is sent up every ten minutes. The advantages gained by the introduction of the sound rocket are indisputable, in one particular more especially.

It frequently happens that the sound of a signal intended to be spread over an arc of, say, 180 degrees to seaward, is obstructed, or deflected, by intervening obstacles, so as to cause certain parts of the arc to be immersed in sound shadow, into which the sound penetrates with very feeble effect, and often not at all. This difficulty the rocket has surmounted most successfully.

The explosive charge is carried up to the height of about 600 feet, and is there caused to explode in free air. From the height at which the explosion takes place, the direct sound is sent downwards into places which would be completely hidden from the level at which a gun could be fired, and which would seldom be reached by the sound of its discharge. At Flamborough Head, the gun was placed on the extreme edge of the point, the cliffs being about 100 feet high. But in Bridlington Bay, at a very short distance to the south-westward, the gun was invisible at the sea level, on account of intervening faces and edges of the cliffs. A practical trial of the rocket *versus* the gun at this station clearly showed the value of the former. One man walked along the edge of the cliff, keeping the gun in sight, and several observers were below on the rocks at the foot of the cliff, it being low water at the time. It had been arranged that, upon intimation from the observers below, the man above should signal to the people at the gun station to fire, first a rocket, then a gun. At a quarter of a mile from the point, with a light wind against the sound, the first experiment was made. The rocket gave a loud and sharp report, the gun a dull, heavy thud. At half a mile the rocket was very loud, the gun very faint. At 1¼ mile the rocket was loud and distinct, the gun heard only by two observers, and then only with the most strained attention. The fact of the explosion of the rocket having been visible and audible on each occasion, shows that it was clear of the obstructions which quenched the sound of the gun, and hid its discharge from sight. It should also be mentioned that the charge of the gun is 3 lbs. of powder, and that the explosive charge of the rocket consisted of 4 oz. of cotton powder.

The sound rocket is now in use at Flamborough Head, at Lundy Island, the Smalls Rock, in St. George's Channel, at Heligoland, and at the Tuskar Rock, on the south-east coast of Ireland. The system offers the means of placing an effective fog-signal at a rock lighthouse station, where limited space and accommodation would prevent the establishment of a gun, or signal requiring furnace and machinery.

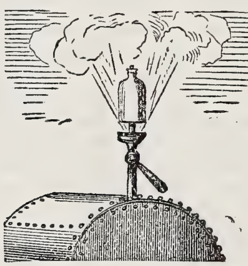
The development of explosive coast fog-signals has not gone beyond this point. Gun-cotton and cotton powder (or tonite) may be handled and stored with quite as much safety as gunpowder; in fact, they are really less dangerous; but it has not yet been shown that other explosive compounds, such as dynamite, lithofracteur, blasting gelatine, or any other nitroglycerine mixture, can be made practically serviceable. Some freeze at a temperature a little above 40° Fahr., and others do not lend themselves to manipulation, and to safe storing for lengthened periods. There is, however, every probability that further advances will be made.

One other form in which explosive signals are now used may here be mentioned. I have alluded to the gun fired at intervals of about a minute being the authorised signal of distress for ships at sea. Mr. Gardiner, of the Cotton Powder Company, has sent me particulars of a kind of signal which may be fired more easily, expeditiously, and effectively than the gun, thereby obviating loading every minute, an important consideration with a vessel in distress. This consists in a small charge of tonite made up into a sort of cartridge. When required to be used, one of these cartridges is dropped into a socket, and by pulling a lanyard attached to a friction tube, a small quantity of powder at the base of the signal is ignited, which blows the charge up into the air about 600 feet, where it explodes. At the moment of explosion some brilliant stars are also shot out, and thus the signal represents either a gun or a rocket, both distress signals. I am informed that many vessels have been supplied with these rocket signals, that their effectiveness is undoubted, and that the Board of Trade have sanctioned their use in lieu of either guns or rockets.

One further application of explosives requires attention, one probably more familiar than agreeable to most of us. I allude to the use of exploding signals on railway lines, to convey signals to engine-drivers and guards in foggy weather, and to do duty for the semaphores and coloured light signals when they are obscured. The system appears to be, that a signalman, furnished with a supply of detonators, places himself near to the signal-box or semaphore in connection with which he works, and uses the detonators to stop a train, if the line is blocked by the fixed signal. The detonator consists of a small quantity of coarse gunpowder, tightly bound up with three percussion caps; it is fixed on the rail with lead clamps, and is exploded by the wheel of the engine going over it. The system is said to be fairly effective; but it is probable that the British public generally would not endorse that opinion, for most people are fully aware of the annoying delays involved by the system, and certainly do not relish

the sudden explosions to which they are treated, while chafing under enforced detention in the train. There seems to be plenty of room for improvement; the system is cumbrous, and admittedly expensive; and we may well hope that a more effective and less objectionable method of signalling in fog may be devised for our railways.

Whistles.—The next instrument which claims our notice is the whistle. We will first regard it in connection with coast fog-signals. For this purpose, whistles, whether operated by steam or compressed air, do not appear to have found so much favour in this country as in the United States and Canada; indeed, with the exception of one station in the Clyde, where two small whistles, sounding different notes, are in operation, there are no fog-signal whistles on our coasts. In the United States they have been employed at various points since the year 1851. The first was set up by Mr. C. L. Daboll at Beaver Tail Point. In Canada, also, whistles have been in use for some time, the type adopted being that invented by



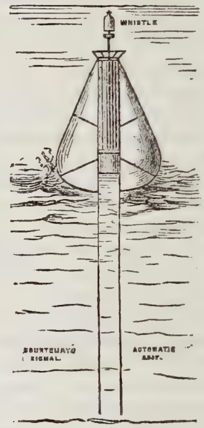
Mr. Robert Foulis, of St. John's, N.B., and known as the Vernon-Smith whistle; and in this country, Mr. W. H. Bailey, of Salford, Manchester, has given much attention to the manufacture of whistles suitable for sound signalling. Steam whistles are simple enough in their arrangements, requiring only a boiler for generating steam, and a simple mechanical arrangement for opening a valve for the periodic passage of the steam to sound the whistle.

For air whistles, it is necessary to have some motive power to compress air, and also some mechanical arrangement to regulate the admission of the compressed air to sound the whistle.

In the Trinity House experiments of 1873-4, it was shown that the sound of the most powerful whistles, whether blown with steam or air, was generally inferior to the sound yielded by other instruments, and, consequently, no steps have been taken to extend their use in this country. Various reports have been circulated as to the great distance at which whistles have been heard on the American and Canadian coasts, but no such results as those claimed were obtained in the very careful trials, made with both American and Canadian whistles, at the South Foreland, in 1873.

The sounding of a whistle is caused by the vibration of the column of air contained within the bell or dome, the vibration being set up by the impact of a current of steam, or air, at a high pressure. It is probable that the metal of the bell is likewise set in vibration, and gives to the sound its *timbre*, or quality. It is to be noted that the energy so excited expends its chief force in the immediate vicinity of its source, and may be, therefore, regarded as to some extent wasted. The sound of the whistle, moreover, is diffused equally on all sides. These characteristics, to some extent, explain the impotency of the sound to penetrate to great distances. Difference in pitch is obtained by altering the distance between the steam orifice and rim of the dome; when brought close to each other—say within half an-inch—the sound produced is very shrill, but it becomes deeper as the space between the rim and the steam or air orifice is increased.

The most recent adaptation of the whistle as a fog-signal is shown in an automatic signal buoy,



devised by Mr. J. M. Courtenay, of New York, by which a powerful whistle, fixed at the top of a buoy, is sounded automatically by the action of the sea. The apparatus consists of a buoy, 12 feet in diameter, with a tube 33 inches in diameter, and 32 feet in length, passing vertically through the centre, and descending below the bottom of the buoy to a depth of about 20 feet, the object of this length of tube being to reach a depth where the water is not subject to wave agitation. The bottom of the tube is open, and freely admits a column of water, which is maintained at a constant level, and is uot affected by the external superficial wave motion. The buoy, however, to which the tube is fixed, moves with the surface undulations of the water, and, of course, carries the tube up and down with it, thus establishing a piston and cylinder movement, the column of water in the tube forming a piston, and the tube itself being a moving cylinder, the weight of the buoy and the tube exercising a considerable pressure. By means of the motive power so established, air, which is admitted by stop-valves into that part of the tube which is above the level of the water, is compressed and forced through a pipe $2\frac{1}{2}$ inches in diameter, communicating with and sounding the whistle at the top.

One of these buoys has been practically tried off the Goodwin Sands for some months, and has proved a success; two more are about to be placed at other points. On the coasts of the United States, France, and Germany, they have also been in successful operation for several months.

Whistles are supposed to be the best medium for making signals by sound on board steam-ships. The regulations which I have previously quoted,

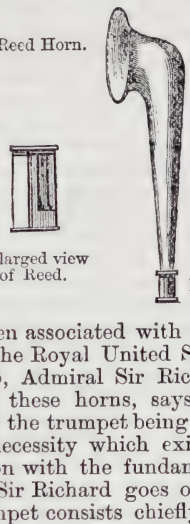
specify the whistle for steamers; but it is necessary that precaution should be taken to ensure the whistles giving effective sounds. Many that I listened to appear to me to be dismal failures, more especially when first sounded, for frequently the condensed steam causes so much water in the pipe, that when a sound signal is required to be made in a hurry, only a rush of water comes through, without any effective sound.

On board the *Duke of Leinster* steam-ship, running between Glasgow and Dublin, a novel form of whistle consisting of an organ pipe fitted on to the steam-pipe, is said to give very superior results. It is said that it does not get choked like ordinary whistles; and that the sound emitted is loud and resonant, without the shrill disquieting tone of many whistles. This instrument is patented by Messrs. Hannan and Buchanan, of Glasgow.

With regard to the use of whistles on locomotive engines, I have endeavoured to ascertain from sundry gentlemen connected with railway engineering (to whom I beg to offer my best thanks for their courtesy in replying to my inquiries), whether this kind of signal is the best for the purposes required, and from the replies I gather that the feeling is, "Well, it might be better, but it just answers." It does not appear that much is known by railway engineers about the construction or shape of whistles, and they seem to share the popular notion that the shriller the sound the more effective it is. Perhaps I may here venture, in the general interests of the travelling public, to utter a protest against the inconsiderate and often unnecessary manner in which whistles are sounded in the great railway stations of this country, and London in particular. I thing it probable that this meeting will sympathise with me when I say that, in these days of nervous susceptibility, and when so many thousands of people travel daily by rail, something ought to be done by the railway authorities to abate the nuisance of unnecessary whistling, and certainly to put down the sudden, shrill, ear-piercing screeches, which make a strong man's nervous system tingle again, and which echo from roof, wall, and ground in reverberating shrieks. There is enough hubbub and racket at all stations, caused by the bustle of travellers, the arrival and departure of trains, the shouting and banging of doors by porters; and though all this may be called exhilarating, yet the addition of whistle screeches is too much to impose upon an enduring public. Drivers and stokers, with their deadened perceptions, are probably not aware of the real pain they often inflict on many persons by their thoughtless use of the whistle. If sound-signals are so necessary, let them be low, soft sounds, or a full-toned bell. Such as are used on locomotives in the United States would be a great relief.

Fog Horns.—The next class of instruments to which reference should be made is the horn, or trumpet, in which air or steam pressure is employed to set in vibration a metallic reed, or tongue, which vibration is communicated to air inside the trumpet, and also to the molecules of the metal of which the trumpet, or horn, is formed.

Mr. C. L. Daboll, of the United States, to whom reference has been previously made, introduced, in 1851, an instrument of this kind to the notice of the United States' Lighthouse Board, and a trial was made at Beaver Tail Point, Rhode Island. This instrument was sounded with air condensed by two air pumps, worked by a horse, the compressed air being stored in a receiver, and the trumpet sounded at a pressure of about 40 lbs. to the square inch. Ultimately, Mr. Daboll employed Ericcsen's caloric engine as the motive power for condensing the air, and an automatic arrangement for regulating the blasts, and in 1862, he introduced his improved signal to the notice of the Trinity House Corporation, who gave it a practical trial at Dungeness. The results being very satisfactory, the Corporation placed other instruments of the same kind at several places round the coast, and one was fitted up on board the Newarp light-ship. The experiments at South Foreland showed such instruments to be, under some conditions, very efficient, but they suffered from several disadvantages, which have led probably to their disuse of late years. I have alluded to the fact of some of the initial power being wasted in the case of whistles, by the metal of the dome, or bell, being set in vibration; this occurs to a greater extent with the huge brass trumpets which have



generally been associated with reeds. In a paper read before the Royal United Service Institution, in May, 1875, Admiral Sir Richard Collinson, in speaking of these horns, says that "there are objections to the trumpet being made of brass, and also to the necessity which exists for tuning the reed in unison with the fundamental note of the trumpet." Sir Richard goes on to remark, "the use of a trumpet consists chiefly in concentrating the sound into a beam, and thus causing it to be projected through the air with greater force in any required direction. The brass trumpet, no doubt, does this to a certain extent; but as the molecules of the metal are also set in vibration, sound waves appear to be generated from all parts of the external surface of the trumpet, so that, although a very loud sound may be produced in the immediate neighbourhood of the instrument, it is open to doubt whether that sound is transmitted with force to any great distance, its strength being, so to speak, dissipated in the space close to its source." The local noise occasioned by the vibration of the trumpet would be intolerable for any length of time. At the present time there are very few reed instruments with brass trumpets in operation, many of those originally established having been superseded by the siren, an instrument of which I shall speak presently. In connection with the development of reed horns very much is due to Professor F. H. Holmes, whose energy in connec-

tion with the electric light is well known. Under his immediate superintendence and advice two reed horns, sounded directly by steam, were fitted on board two light-vessels sent out to China, and have worked very satisfactorily.

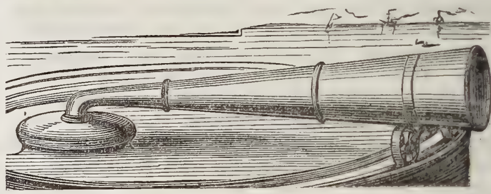
Reed horns are also used on board ship, chiefly sailing vessels, in compliance with the compulsory fog-signals, and the optional sound signals, in connection with the "rule of the road" at sea. The horns now exhibited are lent for this evening by Mr. Nathaniel J. Holmes, of Holmes' Marine Life Protection Association (Limited). They are said to be very effective, but in a seaway, with the vessel rolling heavily, the seaman has some difficulty in working the instruments. It is air pressure which sets this reed in vibration, and produces the sound. In some trials recently made by the German Admiralty, these horns held a commanding position.

Recently, there has been brought into this country, from the United States, an apparatus known as Barker's marine safety signal, intended for use on board ship, to make sound-signals. The apparatus has many merits, one of which is its simplicity in working; a second is that every signal is sounded automatically when once set; and a third is that, with the horn attached, it gives a very good sound. Compressed air is employed at a pressure of 6 lb. to the square inch, and the sounding principle is a reed for the horn; but the inventor says, it can be equally well connected with the steamer's own whistle. The main object of the inventor appears to be to bring into use a short code of compass signals, by means of which vessels can indicate to one another their respective courses, the signal system consisting of eight combinations of long and short sounds. But it may be observed that the adoption of his code would make it necessary for the law to be altered, there being no permission or obligation to employ such signals in the rules now in force. And, again, the principle of long and short sounds which has been adopted, does not commend itself for service at a moment when there is no time to lose in deciphering the meaning of a sound signal from an approaching vessel. Captain Barker, however, has evidently had these considerations in his mind, for, in his descriptive pamphlet, he remarks that, though numbers of practical seamen consider the suggested code to be the simplest and best as yet brought forward, its adoption is by no means a *sine quâ non*, since the machine can, with equal facility, blow any code which may be decided on. Captain Barker would probably do well to adapt his machine to sound only those signals provided for in the regulations.

Sirens.—We now come to the instrument which has been authoritatively described as "beyond question the most powerful fog-signal which has hitherto been tried in England." In 1872, a Committee from the Trinity House, who went to the United States, witnessed the performance of an apparatus known as the siren, and patented by Messrs. Brown, of Progress Works, New York, and in the experiments at the South Foreland one of these instruments was sent over to be tried.

The instrument sent from America could be sounded either with steam or compressed air, made to pass through a fixed flat disc, fitted into the throat of a long trumpet, connected with the steam or air pipe. This disc has twelve radial slits, and behind it is a rotating disc, with twelve similar slits, the rotation being effected by separate mechanism. Imagine, then, the pressure of steam or air to be on, with one disc fixed, and the other rotating; it will be understood that the slits in each frequently coincide—in fact the twelve slits in one revolution coincide

Enlarged view of Siren Disc.



twelve times, and at each coincidence a puff of steam or air, at great pressure, escapes through into the trumpet. It is the rapid succession of these puffs which form the sound of the siren. The disc is rotated so as to make 2,400 rotations in a minute; and as there are twelve coincidences in a revolution, it follows that the number of puffs passing through in a minute would be $2,400 \times 12 = 28,800$.

It can readily be understood that a sound of surpassing power is thus generated, and as the vibrations produced are not taken up by the cast iron trumpet, the sound issues from the mouth in a condensed beam of great intensity.

It is not of importance to record the longest distances at which the siren has been heard, the sound-range under different atmospherical conditions being so exceedingly variable; but in regard to its superiority over other instruments, we may say that, under meteorological conditions unfavourable to the transmission of sound, the voice of the siren had a greater range than that of any other sound-producer; and that, when local noises—such as those of wind in the ears, rattling of rigging, breaking waves, shore surf, paddle-wheels, and the working of engines—have to be contended with, "its density, quality, pitch, and penetration, render it dominant over such noises after all other signal sounds have succumbed." It is obvious that this power to overcome obstructions is the true test of the value of a sound signal, and it is not surprising that the experience of the siren at the South Foreland should have led to the extensive adoption of this form of fog signal on the coast of Great Britain. Since 1874, no less than 22 sirens have been placed at the most salient light house stations on our coast, and 16 on board lightships, moored in positions where a guiding signal is of the greatest service to the passing navigation. It should be added that, in the experiments, steam alone was used for sounding the siren; but the instruments now in operation on our coasts are sounded with compressed air, the motive power being caloric engines of greatly improved design and construction, examples of which are in exclusive use at the Lizard, both for the electric lights and the fog signal. Steam is not available at many lighthouse stations, owing to a scarcity of fresh water; and the caloric engine, which also

rotates the siren disc, is regarded as safer and more economical in working than a high-pressure steam boiler, and is independent of water supply. In America, Canada, and some other countries, steam has been employed with considerable success.

At Howth Bailey, a gas-engine is employed as a motor for compressing air for the siren now in operation there. This arrangement is due to Mr. J. Wigham, of Dublin, and is said to work very efficiently.

Messrs. Stevenson, of Edinburgh, have proposed that the Perkins engine should be employed as the motor for siren signals, but I am not aware that this suggestion has yet been carried out.

The adoption of the Siren as the most efficient sound signal for use in foggy weather, may be regarded as an important epoch in the history of the development of the use of such signals. Improvements have been made by Mr. James N. Douglass, engineer to the Trinity House; and Mr. Slight, superintendent of the Trinity House workshops, has invented an improved arrangement by which, instead of flat discs being used, the siren consists of two concentric cylinders, with slits in both, one inside the other, the outer one being fixed, and the inner one revolving, with the smallest possible clearance between them. The advantages of this arrangement are, that the suddenness of letting on or taking off the pressure is much increased, whereby the successive blows upon the air are rendered much sharper, and the sound intensity augmented. It is also considered an improvement mechanically, by somewhat lessening the friction; Professor F. H. Holmes has succeeded in rendering the rotation of this siren cylinder automatic, with perfect control of the speed and consequent pitch, and an apparatus of this kind has not long since been fitted on board the light-ship at the Seven-stones.

It seems probable that before long the siren will be brought into more general use for maritime purposes. Already it has been introduced into the Royal Navy, for which service Professor Holmes has supplied three small-sized instruments. Messrs. Sautter, Lemonnier, and Co., of Paris, have also produced a steam siren, which they claim can be used not only as a fog signal at lighthouse stations, but also for ships, and, in a smaller form, for locomotives, in the place of the whistle. Mr. Wigham, of Dublin, has also designed a form of siren for steamships, driven by a small turbine, actuated by the current of steam or air by which the instrument is sounded, the rate of rotation being controlled and rendered uniform by a simple governor.

Messrs. Sautter, Lemonnier, and Co. have more recently introduced a double siren, in which two sirens, having different numbers of orifices in their respective cylinders, produce simultaneously two notes in the trumpet, and by this means the power of the instrument is more than doubled, and a characteristic feature is given to the sound.

It now remains to offer a few general remarks upon the subject.

It is obvious that, with the increasing use of sound signals, there is an increasing necessity for differentiating them. Something must be done to prevent one from being mistaken for the other; in fact, it is necessary that every signal should have its own characteristic. This essential element, as regards coast fog signals, has by no means been overlooked, and as each lighthouse is made to proclaim its own individuality, so every fog signal established on our coast has been made to particularly indicate itself by some distinguishing feature. One great reason why explosive reports, whether from guns or rockets, are made use of, is because their sound is so entirely different from that of the blast of a siren, a reed horn, or a whistle. Indeed, the three latter strongly resemble each other, and can only be distinguished by trained ears. It has also been found useless to attempt to get differential signals by means of pitch of the note alone. To employ a high note at one station, and a low note at another, would, in the present condition of the musical cultivation of mariners generally, be more likely to lead to confusion and disaster; although, as Sir Richard Collinson observed, in 1875, it might be possible to obtain an effective distinction by sounding a high and a low note in direct contrast. It has been frequently proposed to introduce long and short blasts; but here, again, experience has shown that many difficulties and risks would attend such an arrangement, and might result in conveying wrong information to the mariner, and lead him into danger. For real practical utility it has been found that, for the present, it is best to trust to the distinctions which may be obtained by varying the number of blasts, and the length of the silent interval. This is a system which is intelligible to the most ordinary understanding; and, accordingly, it is on this basis that the characteristics of sound signals are founded. By making the blasts to occur in groups, and varying the length of the intervals between the groups, on the same principle as that now applied to the new class of group-flashing lights, sixteen fundamental distinctions may readily be obtained, thus—commencing with an interval of half a minute:—

1 blast	every	½ minute	3 blasts	every	½ minute
,,	,,	1 ,,	,,	,,	1 ,,
,,	,,	2 minutes	,,	,,	2 minutes
,,	,,	3 ,,	,,	,,	3 ,,
2 blasts	,,	½ minute	4 blasts	,,	½ minute
,,	,,	1 ,,	,,	,,	1 ,,
,,	,,	2 minutes	,,	,,	2 minutes
,,	,,	3 ,,	,,	,,	3 ,,

The introduction of compulsory and optional sound signals in the new regulations for preventing collisions at sea, has naturally much extended the use of sound signals on board ship, and there can be no doubt that such signals should be entirely different from those made at fixed fog signal stations. It is said that already some difficulty has arisen in reference to the clause in the regulations, which enacts that in foggy weather a steamer shall sound a prolonged blast at intervals of not less than two minntes, the fact being that several coast fog sirens sound the blast every two minutes. Unless checked, this, perhaps, is a danger likely to go on increasing as ships' sound signals become more powerful and more generally used.

One point occurs to me, in connection with those gentlemen who give much time and trouble, and, probably, spend much money, in developing sound signals. I observe that they all take up some special code of signals, and then show how well their instrument is adapted for it. Now, if I might

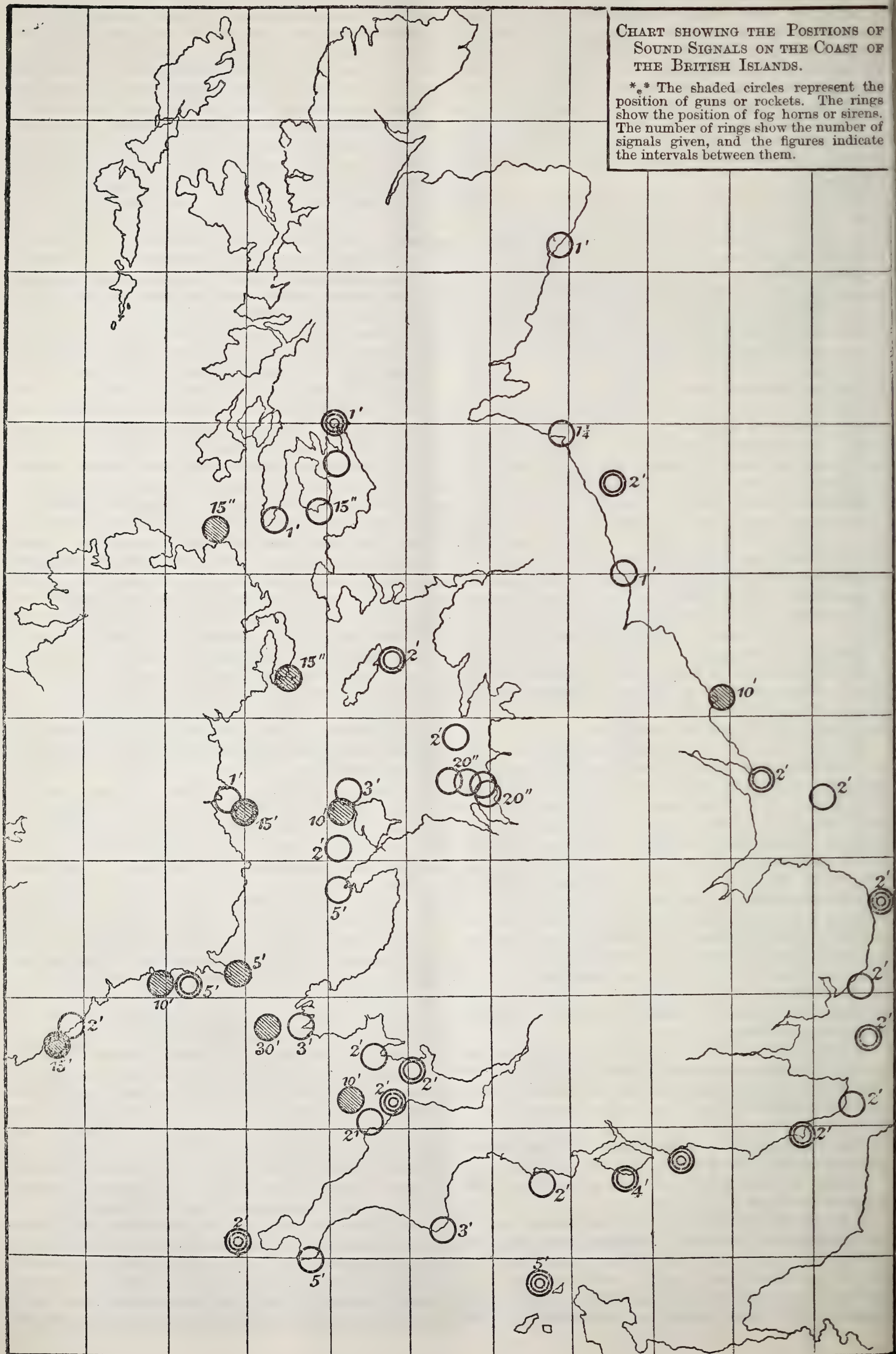


CHART SHOWING THE POSITIONS OF SOUND SIGNALS ON THE COAST OF THE BRITISH ISLANDS.

⁎ The shaded circles represent the position of guns or rockets. The rings show the position of fog horns or sirens. The number of rings show the number of signals given, and the figures indicate the intervals between them.

give a piece of advice to those gentlemen it would be, first look at the law, and see what signals are provided, then adapt your apparatus, whatever it may be, to making those signals. Don't require the law to be altered to suit your instrument—that is putting a real difficulty in the way; but make your instrument suit the law as it now exists.

I may remark it is not easy to see how the system of long and short sounds can at present be brought into satisfactory operation. Such distinctions are extremely pretty and simple upon paper, but they assume a vastly different aspect in the mind of an anxious and, perhaps, not over intelligent master mariner, on board his vessel, say in the Downs, in a thick fog. All around he hears horns and whistles blowing, and all he attempts to do is to keep clear of those vessels which, by the sounds, appear to be nearest. Of what use, then, would be the combinations of long and short sounds? Would he, in his bewildered state, care to try to distinguish between them? I venture to say he would have neither the time nor the inclination to do so; and it must not be forgotten that, in making provisions of this kind, it is not the skilled, clear-headed, highly-educated, Royal Naval or merchant captain you have to consider, so much as the thousands of experienced, weather-beaten master mariners, who know well how to navigate their vessels under trying circumstances, but whose minds are not adapted for comprehending any system requiring accurate and attentive observation, to which is tacked on the necessity of finding out the meaning after the observation is made.

As regards the present development of our coast fog signals, there is every reason for congratulation. A glance at the map will show how extensively they have been applied. This new branch of coast marking has been brought up to a very effective condition; no efforts have been spared to cope with the seaman's greatest enemy, fog, and the remarks which I have had the honour to address to you indicate with what success these efforts have been attended. By the aid of sound signals, the mariner is now enabled to continue his voyage with comparative safety, even when his vessel is enshrouded with a thick pall impenetrable by the keenest vision; and there is little doubt that those who have their business in the great waters are ready gratefully to acknowledge the humane spirit which has prompted the development of these signals, as well as the practical benefit which they derive from them.

DISCUSSION.

Admiral Sir Richard Collinson, K.C.B. (Deputy-Master of the Trinity House), congratulated the Society on having asked Mr. Edwards to prepare this paper. Mr. Edwards accompanied his predecessor to America, and ever since that time had been, as his private secretary, more or less connected with all the experiments which had been made; he was, therefore, eminently fitted to explain the development of this system. It was not as yet perfect, for, as had been said, they had still to bring to their aid high and low notes, with which experiments were about to be made. The recent rule of the road called on merchant steamers to make certain signals in fogs closely resembling to the fog signals on shore; this created a difficulty, and it would be necessary to find some means of distinction. They had received many communications on the subject of these fog signals, the majority being in their favour; but when a man had successfully made his voyage, he did not think it necessary to say that he had been aided by the fog signal, whereas if he got on shore he was pretty sure to say he did not hear it. The air was such a subtle element that he hoped no seaman would ever put his faith in fog signals, but always have recourse to the lead. What he wished to impress on the seafaring people of the world was, that the fog signal was an auxiliary to navigation, but that it could not always be depended upon. Last year he received a very pleasant letter from Captain Schultz, commanding the Danish frigate *Sjalland*, dated from the Sound, Copenhagen, in which he said, "One, amongst thousands, I offer you my best thanks for what the Corporation has done for mariners in giving them fog horns, especially those at Dungeness and the South Stack light." He then went on to give the details of a voyage he made, starting from Portsmouth in a fog, which showed that he took all the care in sounding which a navigator ought. He concluded by saying, "The end of all this minute description is to show that by going back through the reckoning from our position at half-past seven in the morning, I found we heard the first sound of Dungeness fog-horn to windward at $7\frac{1}{2}$ miles, and lost the sound on the lee side at a distance of $2\frac{1}{10}$ miles." This was gratifying testimony to the value which these signals were to ships. Mariners were now becoming more accustomed to them, and no doubt they would enable vessels to shorten their voyages, but he would again repeat that they should not trust to sound alone.

Admiral Sir Erasmus Ommanney, C.B., F.R.S., said steam whistles and fog-horns had been introduced since he was on active service, but he was glad to learn they were now being reduced to a system, and becoming of such great service to seamen. Living near the Solent, he frequently heard the sound of these horns, and they often puzzled him in listening to them, for he had great difficulty at times in knowing in which direction the sound came; especially in calms. He would, therefore, join in the caution uttered by Sir Richard Collinson, not to trust to sound alone. His only experience of them at sea was as a passenger, but it was enough to show him that if not used with great care, and if there was too much similarity between them, they might lead to confusion and danger.

Captain Sir George Nares, K.C.B., F.R.S., remarked, that speaking, not as a sailor, but as one living for the present on land, it seemed very desirable, while giving the navigators the sound, to screen it from the shore; for they were now creating rather too powerful a sound for the neighbours of the lighthouses and signalling stations. The whole subject of sound signalling was brought about by the question of time. In the old days, they could trust to the lead, turn the vessel's head off shore, and as the depth increased, the mariner knew that he was taking care of himself and his ship, but nowadays they must make their 10 or 13 knots an hour, and, therefore, they must have siren signals to run up St. George's and the English Channel; indeed, these were called for to an increasing extent. Mr. Edwards said he could give 16 different sounds; and that was all very well; but every year the number of ships was increasing; and it was not only the fog signal on shore which sounded, but those from all the ships in the neighbourhood; so that something more than 16 signals was required. They wanted a diversity of sounds, and it had been stated that that was what the Trinity House were now aiming at. They would probably have to introduce different musical notes, and the time might come when every lighthouse would be playing a different tune.

Mr. James Douglass (Engineer to the Trinity House) said he could not add much to what had been said by Mr. Edwards. His part in the matter had been connected with the mechanical develop-

ment of the system. But with regard to Sir E. Ommanney's remark about the difficulty of determining the direction of the sound, he might say that he (Mr. Douglass) had been tested by the Chairman on that special point; he had been desired repeatedly to tell, blindfold, the direction of the sound, and he generally came within half a point of it. When that could be done, he thought you might depend pretty fairly on the direction of a fog signal. It was quite true that echoes sometimes interfered; and when hearing the secondary sound, you might be baffled as to which was the primary one. When you heard vessels sounding horns in all directions, and in addition to that, got echos from the sides of the vessels and the sails, you had a perfect Babel of sounds, and certainly a coast signal would require a distinct code of its own, which should be unmistakable. He had lately had the honour of discussing the matter with Professor Tyndall, and he then thought there was a possibility of a code being formed, perhaps by a combination of high and low sounds, succeeding each other in rapid succession, by which lighthouses and light vessels would give perfectly reliable signals. With respect to the siren, when the original form, with the disc, came into their hands, it was found to be the most efficient signal then known, but they were now able, by Mr. Slight's improved form with cylinder, to economise the quantity of air or steam used, so that the same result was obtained with one-third the quantity, and, consequently, with a like economy of motive power. There was, further, the application of the controlling power or governor, invented by Professor Holmes, so that they could now make an automatic siren, requiring none of the gearing used in the old form. This could be constructed so as to produce any given number of vibrations per second, and, consequently, either a high or low pitched tone.

Mr. Cooke said he had seen a bell buoy off the coast of Cornwall, and also in the Mersey, near Liverpool, and heard sailors speak in favour of them.

Dr. R. J. Mann having expressed his high appreciation of the able manner in which the subject had been treated, said there was one remark in the paper which was of particular interest to him, viz., the peculiar way in which differences of sound often failed to be distinguished even when the sound itself was distinctly heard. He was now realising that fact himself. He had fortunately a keen and excellent hearing, which had served him well all his life, but latterly he had been told that he was getting deaf. He was rather surprised at this, and had been observing carefully to find what was the real fact. He found this peculiarity, that while he could hear sounds quite distinctly, even light sounds in the street, yet when his wife spoke to him he did not hear what she said. This seemed to show that the peculiar deafness which came over a man in advancing years was due to a want of power to distinguish sounds, and he believed that was the form in which the deafness of advancing life primarily showed itself. Every syllable uttered by Mr. Edwards he had heard most distinctly, but it sometimes happened elsewhere that he failed to distinguish a good deal of what was said.

Mr. W. H. Preece was rather surprised that no reference had been made in the paper to the proposal which he knew had been put before the Trinity House by Sir William Thomson, that a system based on that of telegraphy should be applied to the lighthouses, so that they might speak in signals to the mariner in such a way, that wherever he might be he should know where he was. The map on the wall showed, that on entering the English Channel, there were three prominent points, the Lizard, the Start, and the Caskets; and it was perfectly clear that if each of those lighthouses were supplied with a siren, which should shout, in stentorian tones, "I am the Start," or "The Lizard," no one could possibly make a mistake, if he understood English, though a Russian or Danish sailor might still be puzzled. To make this system still more universal, Sir William Thomson proposed that every lighthouse should indicate its position in telegraphic language, which was this. Instead of using common words, the names were spelled out in high and low tones, or by long and short sounds, or by dots and dashes, but generally by long and short sounds, which were to the telegraphist as clear and distinct as language. Every telegraph station in the kingdom had its own particular name—Liverpool being Lv., Edinburgh, Eh., and so on—and these codes were used by telegraphists in commmunicating with each other, instead of the full names. These codes were composed of precisely the same signals as were used by the Trinity House, to distinguish their different lighthouses. Eh. was composed of a short sound, followed at a brief interval by four other short sounds. By this code a lighthouse might be flashing out its name all night long in this telegraphic language. And not only could it do so by means of light, but it could do so by means of sound. They only need arrange the fog-horns, sirens, or whistles, to repeat these signals after each other in a certain preconcerted way, so that whether by day or night, in clear weather or fog, a mariner who had once learned this language, when he came within range of a lighthouse, could not fail to know where he was. He knew there were serious objections to the application of this method to lighthouse purposes; the Elder Brethren were not likely, in a light way, to set aside a plan proposed by so high an authority as Sir William Thomson, and which had been practically adopted at Belfast and at some place on the Clyde. He was, therefore, rather anxious to hear from Mr. Edwards what practical objections there were to the use of a system which, in the ears of any one trained to telegraphy, was as distinct as if each lighthouse were to stand up boldly out of the water and cry out its own name. With regard to Mr. Courtney's automatic buoy, he happened to be in America some three or four years ago, when it was being tried off Sandy Hook, and although he was four or five miles from it, he heard a loud roar like the wailing of a melancholy buffalo, which reached to a great distance, much to the annoyance of the longshore men, but to the great comfort of mariners. People must not be selfish with regard to horns and the whistles of locomotives, which were the language used by the driver to communicate with the signalman. He could say, from long experience, that the whistle was never used unless it was required; the driver suffered from it as much as anyone else, but it was essential to the safety of the train. So with regard to fog-horns; they ought to rejoice at a system which secured the lives of so many people.

Mr. S. J. Mackie wished, in the first place, to give the credit which was due to Sir Richard Collinson of having been the first to apply explosive signals, for he was the first who sent up an explosive signal rocket. When, some years ago, he was making his first attempt at explosive signalling, he received the greatest attention and kindness from Sir Richard Collinson; and he wished to add a few words on the merit of gun-cotton for signalling purposes. Guns required to be kept in order, and from the time taken in loading could not be fired oftener than once in ten minutes, whereas gun-cotton signals could be fired with certainty once a minute; they could also be made, by using double and single ones, to represent the dot and dash of the telegraphic code. There was also this great advantage, that gun cotton could be used for what he called "above-ground signals." He preferred these for many reasons. You could regulate the height according to the distance you wanted the sound to travel; and in some experiments made at Folkestone it was found, when the height above the pier was properly calculated, although the weather was stormy, and the passengers were talking on deck, it was distinctly heard by the steamer at a distance of five miles. There was also this advantage,

that when the explosion was produced in the air alone it did not affect the stability of the ground or foundation of the lighthouse, as might be the case with firing a gun repeatedly. Gun-cotton could be used in all weathers, not being affected by damp, and the sound went equally in all directions; when fired from Folkestone pier it was heard at Dover pier and at Hythe, whilst the lighthouse at the back screened the sound from the town.

Mr. Liggins said he had been accustomed all his life to navigate the English and St. George's Channels, and he would mention one or two circumstances which showed the advantage of sound signals. The last bell buoy he saw was one which he remembered being introduced by his late friend, Captain Peacock, and the last time he saw it, the sea was so calm that the buoy did not move, and, consequently, the bell did not ring. That showed the advantage of having one of Courtney's automatic buoys. On another occasion, crossing the English Channel on a calm summer's day in the mail-boat from Calais, they almost ran upon the South Foreland, and had only just time to stop the vessel and turn astern to prevent running on the beach. If there had been a loud siren blowing such a thing could not have happened; but this was about 20 years ago, before such signals were introduced. On another occasion, he was in a West Indian mail-boat going down the Thames, and ran on the Red Sand in a severe snowstorm. It would have been prudent not to go beyond the Nore, but so anxious were the directors to get the new ship round to Southampton that they ran the risk. The sea was soon over the ship, and they were in the greatest jeopardy; then a most remarkable thing occurred. They desired to fire signal guns, and they had two nine-pounders on deck. He himself saw the red-hot poker put to the touchhole, but neither he nor his friend by his side heard the sound of the gun. Whether the severe weather paralysed their sense of hearing, or the snow prevented their hearing the sound, he could not say. Happily they were seen by a smack, and were soon got out of danger. There were many difficulties in the way of adopting Sir William Thomson's suggestion; it was often very difficult to see the glimmer of a light at all, and after all, the sheet-anchor of the mariner in time of danger was the lead.

The Chairman having complimented Mr. Edwards on his paper, said the perspicuity with which he had treated the subject was only a prolongation of the clearness, intelligence, and tact which he showed when he was at his (the Chairman's) side, day after day, during those memorable experiments which the Elder Brethren had instituted at the South Foreland. The causes which obstructed sound in the atmosphere were mainly two. The wind, in the first instance; and secondly, reflections from what he had called acoustic clouds. Professor Stokes's explanation of the influence of the wind, which had long been a perplexity to scientific men, was this. Supposing an explosion to occur, the wave passed away on all sides, so that it might be conceived at a little distance as forming an arch over the earth's surface. For the sake of simplicity, we may take a short portion of that wave near the surface, and consider it straight and vertical; it would move on horizontally, supposing nothing occurred to make it move quicker at the top than the bottom, or *vice versa*. But now take a case of the wind blowing in an opposite direction to the sound. The wind above was not so much affected by the friction of the earth's surface as it was below, and, therefore, the wind above would move quickly, and, consequently, the sound wave moving through it would be tilted backwards, and assume a slightly slanting direction. Now, the progress of a sound wave was always at right angles to the face of the wave, and, therefore, according to Professor Stokes — and it had been verified since — when the wave was thus tilted backwards by the wind, it gradually ascended, and passed over the head of the observer instead of coming to his ears. The acoustic clouds had been sufficiently described by Mr. Edwards, who, with himself, had made some remarkable observations upon them. They could be imitated. That room was now filled with acoustic clouds. From each mouth issued a column of warm air, and in passing from one portion of air to another of different temperature, or differently saturated, a certain portion of the sound wave was always reflected, and when this occurred extremely often, the sound was entirely wasted in these echoes which occured in the air. Hence there might be invisible acoustic clouds, which behaved towards waves of sound as an ordinary cloud did towards waves of light. Various observations had been made upon the sound sent back from these invisible clouds, and he well remembered, one perfectly clear day, the surprise Mr. Edwards experienced when he heard the trumpet above them sending forth its powerful notes, and those notes coming back from the air in front of them. They seemed to come from the wide expanse of ocean, for there was nothing apparently to yield an echo. With regard to the experiments with gun-cotton, Mr. Edwards had mentioned the cause of its efficacy, which was this. If you pushed your hand through the air there was a tendency to produce a wave, but no sound was audible, because the air was so easily moved that there was none of that condensation and rarefaction behind, which was necessary to form a sound-wave; the air slipped away in front, and closed in behind as you moved your hand. Hence the importance of imparting a sharp shock to the air, in order that it might not thus exercise its mobility. This was what gun-cotton did, and that was the advantage of using gun-cotton, or the cotton powder to which Mr. Mackie had referred. In these matters, he believed a most important step had been justly referred to the Deputy-Master of Trinity House, the use of a rocket to carry a mass of gun-cotton 800 ft. or 900 ft. into the air, where it exploded. You could in that way get the sound into alcoves and bays, which were entirely shut off from a signal fired on the ground. If he dared speak further on the subject, he must say that it was pleasant to him to think of the days he spent beside that distinguished Arctic navigator, who was the inventor of this gun-cotton rocket. The manner in which he held on to those laborious experiments at the South Foreland, always at hand, commanding the vessel, moving her about, making observations with the sextant, he should never forget, for a better or nobler fellow labourer he never had. The subject Mr. Preece had brought forward had already occupied the attention of the Elder Brethren, but in dealing with sound it was not really so easy as one might be led to suppose, and he believed his remarks were chiefly addressed to light. But, no doubt, in the investigations which were about being made, no trouble or labour would be spared to get to the bottom of the question of differentiating one sound from another, and, if possible, arriving at the ideal state of things when a signal station should by means of its sound tell its name. That was the ideal to aim at, and the man who aimed at the sky, as Chesterfield said, would, probably, reach higher than the one who only threatens a tree. So, by aiming at the ideal Mr. Preece had put before them, the Elder Brethren might attain a degree of perfection, which otherwise they might not accomplish.

Mr. Edwards, in reply, said he would only refer to Mr. Preece's remarks. Mr. Preece said that every man who could speak English would be able to read the long and short sounds or lights signalled at sea; but he should have added—if he knew the Morse alphabet, which was itself a difficult thing to learn. He, as a distinguished telegraphist, of course had it at his fingers' ends, but it would not be so easy, say ,to the master of a collier, who had not very much intelligence.

He knew how to navigate his vessel, but if he were put to analysing these sounds, he would be saying to his mate, "Bill, was that a long or a short one?" and, if he had not a watch, was he to fetch a clock from the cabin, and calculate how long a flash lasted, whether it was half a minute, or a quarter, or ten seconds. It was not reasonable to suppose that a captain of a collier, and many other men of even less mental calibre, could appreciate what Mr. Preece thought so easy.

The Chairman then proposed a vote of thanks to Mr. Edwards, which was carried unanimously.

CORRESPONDENCE.

PREVENTION OF FOG AND SMOKE.

It is with much satisfaction that I observe that Dr. Alfred Carpenter is to read a paper on this important subject before the Society on the 8th of December. At the Great Exhibition of 1862, Mr. George Devey, architect, and I, had a joint exhibit in connection with the subject. Since that time I have had occasional letters thereon in the pages of the *Journal*, and also in the *Times* newspaper, and it seems to me desirable to present your readers with a brief review of this matter as a preparation for the discussion which will follow the reading of Dr. Carpenter's paper.

A summary of the facts connected with this smoke question will be useful. There are about 550,000 houses in London furnished with about 5,000,000 chimneys. Of these chimneys, in winter, probably about 2,000,000 are daily vomiting visible smoke into our atmosphere. The calculation is, that this smoke by its effect on house paint, furniture, works of art, and body linen, costs the inhabitants of London £2,000,000 sterling a year. There are about 6,000,000 tons of coal consumed annually in London, of which it is calculated that about one-tenth part escapes as smoke, that is, unutilised carbon, the estimated value of which loss is £600,000 a year. The density of London smoke fogs arises from the presence of moisture in the air, which moisture is partly occasioned by the damp clay of the London basin, but chiefly by the large volume of river water meeting the sea water at a different temperature, and hence condensation of watery vapour takes place in the valley of the Thames, but particularly at the mouth of the river, and hence our great smoke fogs chiefly occur when the current of air comes from the east.

Paris not being in the proximity of large masses of water enjoys a comparatively dry and clear atmosphere. Our geographical and geological position cannot, of course, be altered, but we can do much, so far as the smoke nuisance is concerned, to amend our unhappy condition. Beyond the 2,000,000 house chimneys which in winter pollute our atmosphere, we have the chimneys of several thousand factories. With regard to the smoke produced by these factories, including bakeries, and I may add the chimneys of the kitchens of the West-end club-houses, the remedy is quite within the scope of the Smoke Nuisance Acts passed by Parliament. All that is required, is that these Acts be somewhat extended, and the machinery for carrying them into execution be simplified and rendered more peremptory.

At present, the police only can lodge complaints, and the practice is to give two warnings previous to issuing a summons before the magistrate, while the average fine inflicted does not exceed 30s. Were any two householders in the neighbourhood permitted to inform, and were the average fine raised to £5, of which informers should receive one half, a few weeks could suffice to extinguish all factory smoke from London, because it is perfectly well known that by careful stoking, or by properly constructed furnaces, or by the use of smokeless fuel, such smoke can be abolished, and that to the pecuniary advantage of the manufacturer.

With regard to the abolition of the smoke proceeding from the two million household chimneys in operation in winter, the remedy is very much more difficult, but the smoke of ordinary fire-places could be abated or abolished by any of the following plans :—

1. By aggregating, say, every five hundred chimneys in one tall chimney, and then by a descending shower of water washing the soot into the sewer there to act as a deodoriser and disinfectant.

This method was proposed by myself and Mr. George Devey, by an exhibit at the Great Exhibition of 1862, but I readily abandon the plan as an interference with the freedom of street architecture, &c.

2. By the use of properly constructed grates—that is grates composed almost entirely of fire clay, with ornamental metal fronts—a great economy of fuel and more powerful combustion is obtained. Grates with perpendiculars bars are said to be better than those with horizontal bars. If grates were all fitted with blowers, to be used on first lighting fires, much smoke would be prevented, as it is on first lighting, or mending fires, that most of the smoke is produced. Dr. Arnott's grate with a closed bottom, where the fire is lighted at the top and burns downwards, produces a less smoky fire than an ordinary iron grate, but the appearance of the fire is dull, and the ventilation of the room imperfect. Dr. Siemens' coke and gas grate, as described in *Nature*, 11th November, is an excellent grate, as I can testify from examination. It produces no smoke, and heats a room 7,200 cubic feet at a cost of 4½d. for nine hours, notwithstanding that probably three-fourths of the heat produced is lost in the chimney.

3. By the use of coal-gas it is well known that cooking can be beneficially and economically managed in large establishments; but under the management of ordinary cooks, gas is an expensive cooking power. Were cooking by gas universal, as in summer kitchen fires only are in operation in our houses, the four months of the London season might be enjoyed in a perfectly smokeless atmosphere. Gas, as a heating power, can be economically used, provided the entire heat produced by its combustion is utilised, because, although gas, as compared with coal, cost for cost, is much inferior to the latter; yet, as three-fourths of the heat produced ascends the chimney, gas, under the above conditions, becomes cheaper than coal. If the demand for gas, for cooking and heating purposes, became much extended, the price of gas could be reduced, and also the price of coke, and thus the gas and coke fire might be cheaply produced.

4. By the exclusive use of anthracite and other smokeless coals, the smoke nuisance of London could be entirely abolished. It is stated that in Wales there are fields of smokeless coal, calculated at ten thousand million tons, equivalent to more than fifteen hundred years of our present London consumption of coal. This coal is perfectly adapted for all furnaces, and can be easily burned in all stoves and fire-clay grates, or in iron grates with blowers. Its freedom from sulphur is a further advantage, and in South Wales it is the usual fuel, both of cottages and towns, and where it is used there is no smoke. It is also used in New York and other towns of the Eastern States, and New York has a brilliant atmosphere, even in winter.

5. Lastly, I draw attention to the American method of warming houses, and as in America, the mercury often falls to zero, it is evident that the best heating apparatus becomes necessary to life. The American

method is to heat the entire house from a furnace in the basement. The furnace is placed in a small chamber, to which the external air is freely admitted; which air, becoming heated by contact with the external surface of the stove, ascends through pipes to the top of the house, there being openings in these pipes into each chamber; such opening being closed at pleasure. Thus it may be said, heat is laid on like gas or water, to be used as required. By this method the heat produced is, or might be, entirely utilised, while a continual current of fresh, warm air is admitted to the house. The hot chamber could be constructed as a Turkish bath, and thus not only heat the entire house, but act as a most luxurious and hygienic domestic arrangement. By heating a house from a central fire, the dust and black smoke of our ordinary fireplaces are avoided, and the servants are saved the labour of carrying scuttles of coal. The American furnaces are chiefly of iron, and the heat produced is sometimes excessive. I should recommend fire-clay stoves, with fire-clay brick flues, as in our Turkish baths. As this central fire has a furnace draught, any kind of coal can be used with smokeless results.

1. The smoke produced by our factories could be at once abolished, and that with advantage to the manufacturers.

2. By the general use of gas, coke, and smokeless coal, the smoke of London could be abolished, and thus £2,600,000 saved to the inhabitants.

3. By cooking with gas and coke, and warming our houses by a central furnace, the smoke of London could be abolished.

4. To secure these advantages even in part, the public, together with surveyors, architects, builders, and grate manufacturers, should act in unison with the producer of gas, coke, and coals. But as the smoke nuisance of London is a rapidly increasing evil, Government may one day find it necessary to place the regulation of our domestic hearths, and our gas, coke, and coal supplies, under some central and paternal government.

GEORGE WYLD, M.D.

12, Great Cumberland-place,
24th November, 1880.

[This letter was in type before the reading of Dr. Carpenter's paper, but was not published owing to want of space.]

As time did not allow me to join in the discussion on Dr. Carpenter's paper I now send you a few remarks upon it. I have been writing about domestic fire-places for seventeen years past, at a great cost of time and money. If I have not succeeded in doing a recognised public service, it is because I have not received the assistance from the press which I ought to have had. They have been willing enough to receive my money for advertisements, but have not taken the trouble to read and understand my books. But now that the subject has come prominently forward, we may hope that it will not be left till a thoroughly searching reform has been commenced.

I will first of all allude to the extraordinary and daring propositions of carrying off smoke by some thousands of lofty chimney shafts, with immense furnaces burning below them, supplied with the air and smoke from our houses. Those who have brought forward such propositions can have no adequate conception of the enormous cost, the overwhelming difficulties, and of the certainty that, after all, the smoke would not be consumed, unless it was done in every separate fire-place.

Now, as regards gas. I do not wish to prejudge, or to say anything that may prevent a fair consideration of Dr. Siemens's contrivance, but I must tell you that, more than twenty-five years ago, my firm entered largely on the manufacture of gas-stoves, and that we abandoned it entirely, in consequence of its bringing us constantly into collision with our customers. The cost of gas was too great, and, in a large number of instances, the products of combustion did not pass effectually away by the chimney. These remarks do not apply to the use of gas for casual purposes, especially those of cookery.

Now, as regards anthracite coal. It is used in Wales, not from choice, but from necessity. It is nearer people's doors, and is very cheap. In using it here, we are asked to use a blower to make the fire burn cheerfully. By this you carry off the air of your room with great velocity, which air must be replaced from your doors or windows, or you will have a sluggish draught in the chimney itself, with a return of offensive products of combustion. If you propose to mix anthracite coal and bituminous coal in equal proportions, you must have machinery for breaking the coal into small pieces, and for mixing the two. You must also be prepared to pay the expenses of scientifically breaking and mixing. If this is not considered to afford a satisfactory solution, we must ask what may be done if we continue to use bituminous fuel. Dr. Arnott pointed out, many years ago, the proper way to use bituminous fuel was by introducing the fresh fuel below the fire instead of at top. A little consideration and observation will show us the utility of this. It is when fresh fuel is thrown on the top of a fire that a quantity of vapour, darkened by particles of carbon, escapes from the fire, and is what we call smoke. If, however, we introduce the fresh fuel below the fire, or burn a body of coal from the top downwards, like a torch or a candle, the vapour passes away invisibly through the hot stratum of coal, and the particles of carbon are consumed. Dr. Arnott's grate had certain defects, through which it never became popular. The objections were the sunk ashpit, the use of machinery, and the heavy appearance of the grate. I have not the slightest hesitation in saying that these objections may be effectually overcome, and, as regards matters of design or taste, Mr. Ernest Turner has kindly consented to give his valuable assistance.

Notwithstanding the objections, the grate has been highly appreciated for a long number of years by highly accomplished men. Sir William Gull has used it, and recommends it to his patients. His own grates were used by his predecessor, Dr. Todd. Sir Roderick Murchison used it with great satisfaction, and Mr. Thomas Burgoyne, a well-known solicitor, changed in the course of ten years the whole of the grates in two large houses in Stratford-place, and told me emphatically, that he had been repaid the cost of the grates by the saving of fuel, over and over again.

Now, as regards the kitchen department, we waste, undoubtedly, an enormous deal of fuel. We produce a large quantity of smoke, and we so fill our flues with soot that they require clearing every week. The matter, however, may be dealt with in a highly satisfactory manner, but only by following Count Rumford's advice, and avoiding the open fire altogether for nearly all the purposes of cooking. For the whole of the hot water required by a household we ought to use a closed fire and burn anthracite coal. This should enable us to have a warm bath at midnight without disturbing servants. For our ovens, used for baking, or ventilated when used for roasting, we should have a separate fire, never to be lighted except when absolutely required, and in this we may burn anthracite coal or coke. For our hot plate we may use gas or anthracite coal. In using gas, we must take care to provide means to carry off the fumes by the kitchen chimney, and in using anthracite coal we require a closed fire-place, and that the hot plate should be made in one piece, with only a round cover over the fire, so that we may get the full benefit of the laws of the conduction of heat, having no heated flame to depend upon.

I am sure that these arrangements can, with a little ingenuity, be combined in the basement of nearly all modern houses. It may be, however, that for very

small households an American stove, to burn coke or anthracite coal, and a little gas boiler, would meet all requirements, and give no smoke.

Now, can we reconcile our servants to this system? I believe we can, but we can only do it by training them. We must provide them somewhere in the basement, with an economical open fire-place, at which they can warm their fingers, and do little domestic offices; such as toasting bread, cooking a chop, boiling a kettle, &c., instead of using the gas hot-plate.

I have now given an outline of the way in which the smoke question, so far as domestic fires are concerned, may be effectually dealt with. We may not get rid of smoke entirely, but if we get rid of nineteen-twentieths, as we may unquestionally do, we shall do as much as can be expected, as long as we retain the use of open fires and bituminous fuel.

I will only add that I hope, after the close of this winter's discussion, to have the privilege of bringing forward the whole subject of the domestic uses of fuel, when I trust I may be able to deal with it more elaborately than at the present time.

Frederick Edwards, Jun.

Great Marlborough-street.

At the discussion on the prevention of smoke fogs in the metropolis, and in large towns generally, it was my intention not only to trace out, as far as possible, the true source of the evil, but to point out the limits within which the remedies obtainable would appear to lie. As it happened, however, I had only time enough to give a brief outline of the first topic, the claims of other speakers to a hearing not admitting of more than a general reference to the second branch of my intended communication to the Society. I wish now to supply that unadvoidable omission.

As the report of the paper and speeches delivered at the meeting will show, I succeeded in proving, from the official returns of the annual consumption of coal in London, and from the admitted data of gas manufacture, that the quantity of water generated by the combustion of raw coal amounts daily to a mass equivalent to a rainfall of one-eighth of an inch over an area of 20 square miles; or, if a smaller surface be taken, of a quarter of an inch over an area of 10 square miles. This aqueous mass, converted into vapour in certain favourable states of the atmosphere as to pressure and temperature, &c., would obviously occupy an enormous volume, and would be sufficient to spread over the whole of London, if limited in height as Dr. Carpenter demonstrated it to be.

I alluded incidentally to the shameful waste of ammonia accompanying the general waste of fuel, due to imperfect combustion in our ordinary fire-grates. This waste will be best appreciated when I state that, assuming the gluten of wheat—the nourishing element in it to be on an average 26 per cent. of its weight and the nitrogen 15 per cent. of the gluten, 13 lbs. per ton of coal being the ammonia, the production of 8,000,000 of tons would be equivalent to 5,200,000 quarters of wheat, taking 60 lbs. as the weight of a bushel. In first quality wheat the gluten is 35 per cent., which would give even a larger number of quarters. This conclusion might seem to be irrelevant to the main question of the fog nuisance, but if we reflect that this important element of fertility is the invariable concomitant of the general waste of fuel, due to imperfect combustion, and withal, an element injurious to the respiratory organs, and to the mucus membrane, we shall perceive that it strengthens, under its double aspect, the claim of the public to a reformed system of heating their dwellings.

At this point it is proper to observe that the most perfect combustion of bitumenous coal could do no more than remove the hydro-carbons in their gross and unconsumed state, the ammonia and the aqueous vapour in the purer fog still remaining unsubdued. If the hot products of combustion were to be conducted through the tubes of a tubular boiler full of cold water, they would be condensed, heating the water in their passage, while the resulting liquid would pass into a receiver, thus collecting the ammonia present. If this boiler were to be constructed with two pipes, communicating with a cistern of water at the top of the house, the warm water would ascend, while the cold was descending, until the temperature in both vessels should be the same. The hot water could be conducted from the cistern above by pipes, to warm the upper apartments of the house, and used for baths and other domestic purposes. This, it is needless to say, applies to only the better class of houses, manufactories, &c. The working classes, lodgers, and others would be restricted to the use of coke, or of anthracite coal, in stoves suitable to their combustion. In this case, the coke must be manufactured somewhere, in or near London, or near the pit's mouth, and then the question naturally arises—"What would be done with the gas?" The answer to this is simple—"The proper application of the gas would be to heating purposes of all kinds, by means which should ensure perfect combustion, and utilise the heat of the products of that combustion." It is implied that the ammonia would be collected in the cooking process yielding the gas. Near iron works the gas could be used in cementing the iron ore preparatory to charging the blast furnace. A simple calculation determining the weight of iron ore reduced by the gas due to a ton of coals would surprise most readers. I only indicate this process as an element of economy.

I now come to an application of both coke and anthracite coal to the production of carbonic oxide gas, which could be conveyed by pipes, like the present lighting gas, to every fire-grate in London. I advocate this with much hesitation, well knowing the fears and prejudices which I have to encounter. It is said by medical men, of great authority, that carbonic oxide is a deadly poison, but, so is carburetted hydrogen in a certain proportion to air of respiration, besides being as explosive and dangerous to life as gunpowder. In common with nitrogen, both gases asphyxiate; whether as a true poison, or by deoxidising the blood, all are equally fatal. But is not carbonic oxide, as well as carbonic acid, at present evolved in great quantities, passing, with nitrogen, sulphurous acid, and sulphuretted hydrogen, up our chimneys, especially from a red hot grate full of coals?

More than this, it is to be noted that carbonic oxide would not be consumed like the present lighting gas, in the midst of our apartments, by burners suspended above our heads, and free, in case of escape, to mingle with the air which we breathe. It would be burned—as it is at present—in the grate, with a current of the heated products of combustion passing up the chimney, and even if escaping unburned, being specifically lighter than air, it would ascend. With anything like a well-constructed and well-ordered apparatus, the gas being led indirectly to the grate from without the walls, accidents to life would not be more frequent than at present from the incautious use of carburetted hydrogen gas in burners. The heat given out by a grate filled with pumice stones, or balls of fire-clay, submitted to the burning carbonic oxide, would be very intense, giving out, too, a bright light, and could be regulated to a nicety by the jets. There are two modes of generating this gas from limestone or chalk, by passing its carbonic acid through red-hot coke or anthracite coal, or by passing steam through the same heated fuel. I prefer the former, because when spent, the produce in lime may be sold to advantage.

But there is a second application to which I invite special attention. By slaking the quick-lime (above all, if spent steam be used for the purpose) in cylinders placed in large reservoirs of water, at least as much heat would be evolved as was originally employed to

vaporise the carbonic acid. The water so heated could be conveyed in well-fitted pipes to a great distance for warming houses, as well as for domestic purposes. The economy of fuel thus attainable in the great city of London would be enormous.

My object is to ventilate the above suggestions, in the hope that their publication may lead to their examination by that large class of ingenious and practical minds habitually devoted to kindred objects, and therefore competent judges of the merits of my system. I trust that I have succeeded in proving that something more than complete combustion is required to prevent fogs. F. C. KNOWLES.

Mayfield, Ryde, 13th Dec., 1880.

It may interest some of the members of the Society of Arts to know that it is quite easy to burn a mixture of coke and gas in an ordinary domestic grate, without going to the expense of fitting Dr. Siemens's regenerative arrangement to it.

I have done so for some time, and first described my system in a letter to the Fog and Smoke Committee, dated 27th October last. Dr. Siemens first described his arrangement in a letter to the *Times*, dated 2nd November. A drawing and description of my grate is published in the *Sanitary Record* of 15th December; but I may say here that the whole thing consists in lining the grate with fire-brick, and introducing small gas jets to play upon the front of the coke, through perforations in an iron gas-pipe laid at the bottom of the grate in front.

I have fitted an "experimental gas meter," by Glover and Co., to one of my grates, and carefully measured the coke supplied to it, and find that the cost of it has never reached one halfpenny per hour, which is the cost of burning a mixture of gas and coke in Dr. Siemens's grate, as given by himself. I find the smokeless fire pleasant, convenient, and economical, but have no interest in any manufacture, or sale of any article connected with it. I hope, for the sake of the atmosphere of London, that it may be extensively adopted, and any person who thinks of having it fitted in his own house, is quite welcome to call and see mine.

COSMO INNES, C.E.

7, John-street, Adelphi.

A patent was granted in 1873 to the Rev. Thomas Wolstencroft, rector of Morton, near Manchester, for "An improved method of warming dwelling-houses and other buildings, economising fuel, burning slack, reducing the bulk of the refuse, improving draughts, and curing smoky chimneys."

The patent consisted in closing in the space between the bottom of the grate and the hearth by an iron movable plate, or back of an ashes-pan, forming a chamber beneath the fire, to which a supply of air was communicated from within or without the room, usually from the space beneath the floor, thus preventing dry rot, or from the room below, so ventilating it; this supply of air was controlled by a valve, which regulated the combustion. In burning coal, a saving of 25 per cent. was effected, while with careful stoking, 45 to 50 per cent. was easily reached. With this stove, coke produces a better fire than coal, as an intense glow or a smouldering fire may be had as desired.

Some hundreds of the grates were fitted in the neighbourhood of Manchester, and satisfactorily; but through insufficient means to work the invention (which also was in the hands of a sole manufacturer), the business and patent collapsed.

The invention may be applied to most grates by an ordinary workman.

THOMAS WOLSTENCROFT.

13, Charterhouse-square, E.C.,
December 14th, 1880.

I was rather surprised to find an old popular error cropping up in Dr. Carpenter's interesting paper upon Fogs; and was the more surprised that it should occur there, because Dr. Carpenter has evidently made a careful study of the subject of fog. Near the bottom of the second column, on page 52, Dr. Carpenter observes, that the most curious effect of the fog "is the obliteration of sound, which prevents one from perceiving the approach of moving objects, until they are close upon you, and moving vehicles suddenly appear like ghosts upon the scene; a noise upon the top of a building is heard much more distinctly than one near the ground." He then goes on to remark, that where the fog was thickest, the sounds were most indistinct. Now, if there is one fact more certain than another about fog, I take it to be the fact that fog is rather a conductor of sound than an obstacle to it. This has been proved by the long-continued observations carried on by Dr. Tyndall on behalf of the Trinity House, and has been further verified by a series of experiments made by the same distinguished philosopher. It is now a received axiom that sound is not impeded by a homogeneous layer of air or fog, but that it is obstructed when it has to pass through layers of various density. It is also, I believe, accepted, that sounds are heard further in dense solid fog than they are in a clear day, when the air, though optically clear, is very likely to be acoustically impervious. It is curious that the error—for error it must be admitted to be—should be so deeply rooted. I have tried on one or two occasions, but in vain, to convince signalmen on a railway that they were able to hear as far in fog as on a clear day; but I have never succeeded in inducing them to believe me, or even to make careful observations after I had talked to them. H. T. W.

[Since the above was written, the subject has been further elucidated by the paper read last Wednesday by Mr. Price Edwards, and by the remarks of the Chairman of the meeting, Dr. Tyndall.]

Now that strenuous exertions are being made to mitigate the evil of London smoke, it is but fair that some notice should be taken of the endeavours made more than two centuries ago, by a distinguished Englishman, with the same end in view. John Evelyn published, in 1661, his "Fumifugium, or the inconveniency of the Aer and Smoak of London dissipated," in which he proposed two presumed remedies. One was, the banishment of noxious trades (such as brewers, dyers, soap boilers, and lime burners) from London; and, the other, the encouragement of plantations. He particularly recommended the plantation of lime trees as an antidote to the evils of London smoke, and it is supposed that the trees in St. James's-park were planted there in consequence of this suggestion. In accounting for the origin of his book, Evelyn says, that while walking with Charles II. in Whitehall, his attention was attracted to the clouds of smoke that issued from chimneys close by Northumberland-house, and adds, that the king commanded him to draft a Bill for presentation to Parliament, by means of which the nuisance should be abated. The author subsequently conferred with the Attorney-General, but nothing came of the suggestion, in spite of its having been made by a king. "Fumifugium" was re-issued in 1772, when the editor referred in a preface to the smoke made by the York Buildings Waterworks; and, in 1822, an analysis of the tract appeared in the *Journal of Science, Literature, and the Arts* (vol. xii. p. 343). X.

The following letter was addressed to Mr. E. Chadwick, C.B., Chairman of the meeting, on the 8th inst.:—

I regret that an engagement, already made, prevents my being present at the meeting of the Society

of Arts on the 8th inst., to hear the paper on smoke abatement in London. I may say that I am sure that the metropolitan gas companies would give cordial assistance in the matter, if from no higher than selfish reasons, because the employment of gas for the purposes of warming, ventilating, and cooking, as well as for motive power, would induce an increased consumption, the effect of which would be to add to our shareholders' profits, and, as under the existing sliding scale of price and dividend the companies are actually in partnership with the consumers, further reduction in the already low price of gas must needs follow.

The gas companies have, thus far, not had very much cause to thank the local authorities, whose object appears recently to have been to prevent the proper lighting of the streets, but you may take it from me that the use of coal gas is, at present, only in its infancy, and it not only can, but will be applied with as much success towards the object you have now in view, as the companies have already shown it to be capable of for the mere purposes of illumination.

J. Phillips, Secretary.

The Gas Light and Coke Company,
Horseferry-road, Westminster, S.W.,
7th December, 1880."

HOUSE-DRAINAGE TESTS.

The system of testing drains by the use of peppermint or Mitcham oil, as used by the Boston Board of Health, as explained at page 16, and by Mr. Innes, as per page 45, is rather indefinite, I consider, for general use. In this case one has only the sense of smell to be guided by, whereas by the smoke test the more definite sense of sight is added to that of smell. The sulphur which I use to raise the smell is also a good disinfectant. Sometimes there are people, too, who have "no noses," and who refuse to believe the smelling evidence as to the drains, &c., leaking, but when the smoke is seen pouring out they cannot get over that evidence. The smoke test is also the most practical one to apply when laying new drains. In the smoke tests I speak of, the smoke is blown into the pipe by means of a fanner. I have used this mode regularly for some years back.

W. P. Buchan.

21, Renfrew-street, Glasgow, 4th Dec., 1880.

It seems to me a pity to waste a good, honest, antispasmodic, like oil of peppermint, down soil-pipes, reversing the adage of putting the beggar on the gentleman. Instead of using "an ounce of the Mitcham oil for each house, that costs 2s. 6d.," I utilise the remainder fluid drawn from my gas carburetter, which, though not "like the sweet south that breathes upon a bank of violets," as a detective, will knock oil of peppermint into a cocked hat.

P. Hinckes Bird.

1, Norfolk-square.

CROYDON BOURNE FLOW.

The following letter from Mr. Baldwin Latham, M.I.C.E., F.G.S., appeared in the *Daily Chronicle*. It refers to the underground river that rises at certain times after a period of considerable rainfall:—

"Under the head of 'Local News from Croydon,' I find it stated in your issue of to-day, that, in the course of a few days, the Croydon Bourne will rise in Marden-park. As the author of the prediction of the rise of the Bourne in Croydon, will you allow me to state that, although Marden-park is, traditionally, the place in which the Bourne rises, the Bourne recently predicted by me will not rise here, and it is very improbable that it will flow at all this year in Marden-park. The predicted Bourne will commence as a small Bourne, flow very much lower down the valley than Marden-park, or immediately below the 'Rose and Crown,' under Riddlesdown, and about 1,500 yards above Kenley Railway Station, and will not commence to flow until after December 11.

"These Bourne flows, which have for many centuries past troubled superstitious persons, have been looked upon to presage 'war, pestilence, and famine,' and there are numbers of instances where a Bourne flow has accompanied great outbreaks of disease, as was the case in the great epidemic of fever in Croydon, which broke out in the latter end of the year 1852; but the Bourne flow was not the cause of this epidemic. On the other hand, as a rule, the healthiest years are those in which there is the largest quantity of water stored in our subterranean reservoirs, but generally the conditions, antecedent to a great Bourne flow, have been favourable to the development of fever and other diseases.

"This occasion will make the fifth year in which I have predicted the date and volume of these mysterious Bourne flows, and up to the present time each prediction has been verified, showing that the cause of these Bourne flows has been taken out of the region of conjecture and placed within the range of scientific demonstration.

"The predicted Bourne will commence to flow at an earlier period than usual, and, in consequence, its probable future volume cannot be predicted with certainty. Present indications show that it will little exceed that which occurred in the spring of 1878. If there should be a large rainfall between the present time and the end of February the predicted Bourne may develop into a large flow and break out in Marden-park, but if this should be the case I should be able to predict its appearance even in that locality before it occurred, as I did the one which broke out there in the early part of 1877.—I am, Sir, yours faithfully,

"Baldwin Latham.

"C E., M.I.C.E., F.G.S., F.M S., &c.

"Westminster, S.W., November 30, 1880."

MEETINGS OF THE SOCIETY.

Cantor Lectures.

Monday Evenings, at eight o'clock. The First Course, on "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." Five Lectures, by Prof. A. H. Church, M.A. Oxon., F.C.S.

Lecture V. and last.—December 20.

Hard paste porcelains, Chinese, Japanese, and European.

MEETINGS FOR THE ENSUING WEEK.

Monday, Dec. 20th ... SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Prof. A. H. Church, "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain." (Lecture V.)
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. E. Ray Lankester, "Growth from the Egg."

Tuesday, Dec. 21st...Civil Engineers, 25, Great George-street, Westminster, S.W. Annual General Meeting.
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. R. Price Williams, "The Question of the Reduction of the Present Postal Telegraph Tariff."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Wednesday, Dec. 22nd...Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. Walter De Gray Birch, "Pictures from the Life of St. Guthlac, a Twelfth Century Roll in the British Museum."

Thursday, Dec. 23rd...London Institution, Finsbury-circus, E.C., 7 p.m. Mr. W. R. S. Ralston, "A Story-telling."
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. A. Y. Walmsley, "The Patent-laws, and their Influence on Trade."

Friday, Dec. 24th ... Quekett Microscopical Club, University College, W.C., 8 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,466. Vol. XXIX.

FRIDAY, DECEMBER 24, 1880.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The fifth and concluding lecture of the first course was delivered on Monday, 20th inst., by Prof. A. H. Church, M.A., F.C.S., on "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain," in which attention was specially directed to hard paste porcelains, Chinese, Japanese, and European. At the conclusion of the lecture, the Chairman (Mr. B. Francis Cobb, Treasurer of the Society) moved a vote of thanks to the Lecturer for the interesting course which he had just brought to a close.

JUVENILE LECTURES.

All the tickets for Mr. Romanes's Lectures having now been disposed of, the issue has been stopped. As all the available accommodation will be required for those members who have applied for tickets, it will be understood that no member can be admitted without a ticket.

The Secretary will feel greatly obliged if any member, who is unable to use his ticket, will kindly send it back.

REFORM OF THE PATENT LAWS.

The Council adopted the following Petition to the House of Commons, at their meeting on Monday, 6th inst.:—

To the Right Honourable the Commons in Parliament Assembled.

The Humble Petition of the Council of the Society of Arts, Manufactures, and Commerce, incorporated by Royal Charter,

Sheweth,—

1. That the Society is deeply interested in the Patent-law, and submits that it ought to be made to conduce, as far as possible, to the progress of the Arts, Manufactures, and Commerce of this country, so as to allow the inventions of the United Kingdom to compete fairly with those of all the world.

2. That the Society, in the years 1850, 1851, and 1852, published reports on the Patent-law as then existing, and that those reports were instrumental in inducing Parliament and the Government to pass the Patent-law Amendment Act, 1852, which completely reformed the law.

3. That the effect of such reform has been greatly to stimulate invention, and has so increased the amounts derived from Patent fees, that they have now reached the sum of £180,000 a-year, of which only about £40,000 are expended in connection with the administration of the law, leaving £140,000 as a tax on the progress of invention.

4. That your petitioners are of opinion that the law still retains some antiquated fictions which should be abolished; that it should be greatly simplified; and that, as Patents relate to Arts, Manufactures, and Commerce, all matters connected with them should be administered by persons having knowledge of Arts, Manufactures, and Commerce, and not by legal functionaries, however eminent.

5. That your petitioners desire to call the attention of your Honourable House to the Patent Museum, which is in an unsafe, overcrowded, building, although it contains unique and valuable specimens of those early mechanical inventions which have revolutionised the Arts, Manufactures, and Commerce of the civilised world; that such Museum is quite unworthy of the Nation, and ought to be replaced by a suitable building, containing accommodation for a Reference Library.

Your petitioners, therefore, pray your Honourable House to cause the present Patent-law to be amended, and its administration to be entrusted to the Lords of the Privy Council for Trade.

And your petitioners will ever pray.

Signed on behalf of the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce,
H. Trueman Wood, *Secretary.*

The Council also appointed a Committee to draft a Bill for submission to the Government.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

SOME POINTS OF CONTACT BETWEEN THE SCIENTIFIC AND ARTISTIC ASPECTS OF POTTERY AND PORCELAIN.'

By Prof. A. H. Church, M.A. Oxon., F.C.S.

Lecture I.—Delivered Monday, November 22, 1880.

Terra-cotta, Bricks, Basaltes, Earthenware, and Unglazed Bodies in general.

There are several opinions now current as to the effect of scientific knowledge upon the artistic value of the products of manufacture. Some persons argue that the evidence afforded by the

consummate beauty of certain Greek vases of the "period of perfection" will suffice to prove not only that a rational, an intimate, and an exhaustive knowledge of the chemistry and physics of ceramic materials and processes is not needed, but also that it is certain to end in what we may term artistic disease, and the death of true beauty. They deem that knowledge, full, exact, unbending, fetters the imagination, and crushes the poetry out of the handiwork of man. Quite on the other side are ranged the devotees of science. Science, say they, must be master. Nothing is satisfactory but mathematical precision. Not content with explaining, by means of all kinds of analytical processes, the causes of the beauty of any product of human skill, these rigid disciplinarians permit no departure from established rule. But, happily, there is a third, and, we trust, an increasing, group of persons concerned with manufactures, who take a broader view of the requirements of the day. They are prepared to welcome every kind of aid, from whatever quarter it may come. They call in the assistance of the chemist to analyse old materials and to search by synthesis for new. They appreciate highly the hereditary and traditional knowledge and skill which, rightly directed by a sense of fitness and beauty, have often in past times been alone sufficient to produce results of the highest excellence. But they will be always on their guard against—they will not permit—the dull uniformity and the complete stagnation consequent upon a mechanical routine, however perfect. They may temper the individual originality, which cannot bear to be always producing the same pot, just as the true painter will not endure the too easy labour of continually painting replicas, even of his best picture. But the judicious director or manager will be ever on the search for new developments in art. He will strive to learn from, rather than to imitate, the productions of other countries and other times. He will press into his service every improvement in machinery, in grinding and washing the raw materials, in enamels and glazes, in kilns and the use of fuel; but he will not allow the accuracy of his processes to exclude the charms of variety and tenderness in his products. He will recognise the importance of the fact that such a thing exists as harmony between the material and its decorative treatment, both as to form and colour. He will not insist upon the application to the finest egg-shell porcelain of designs characterised by rugged picturesqueness, nor will he disgrace a piece of rough-marbled clay with delicate reticulations of coloured golds.

But, after all, is it not clear that, if an excellence of result that will bear the test of time is to be achieved, the highest art-knowledge and the highest art-power must be affiliated to our potteries? The perpetual experimenting (untrained as much of it was) of Wedgwood, would have led to no very adequate realisation in actual ceramic products, had not the sweet and careful neo-classical art of Flaxman been available. With wider research, with profounder insight, with more numerous and more varied available examples of excellence; in description more full—in explanation more exact, in analysis more thorough, in suggestion more fertile, in taste more eclectic—the spirit of to-day, if more exacting than the spirit of yesterday, should at least make the attempt to secure, in some measure, that quality of rounded perfection which inspires our efforts, though, alas! too often only to condemn them. We enjoy greater and more varied opportunities of knowledge, and training, and execution, than Wedgwood, and we shall fail of our duty to ourselves and to our country, if we do not take full advantage of them.

Such views on the connection to be established between the sciences and the arts, which can be enlisted in the service of ceramic manufactures, have long been mine. Thirteen years ago, in an address to the Cirencester School of Art, I used similar language, dwelling with special emphasis upon the right use of the large resources which chemical knowledge bestows upon the art of pottery, and urging temperance in the employment of strong colours and showy glazes. These should be used to decorate and develop the beauty of fine contours and good forms, not to obscure them.

My special object in these lectures requires a few explanatory words. The general title of the course indicates its character, but not the limits which many causes combine to place upon my treatment of the subject which is to engage our attention. What then I propose doing in the present and subsequent lectures, is simply this—to note the relations existing between the chemical and physical qualities of some kinds of earthenware and china, pottery and porcelain, or whatever names we may use for these products, and their artistic qualities, as apprehended by the trained eye. On the one hand, I shall not attempt to offer instruction in practical potting, of which I know far too little for my own satisfaction; on the other hand, I shall make no pretence of scientific completeness in what I say on the chemistry and physics of my subject. From time to time circumstances have led me to analyse, or to examine microscopically, the raw materials and the finished products of certain ceramic wares, and I purpose dwelling upon the connections thus unravelled between texture and composition on the one side, and artistic effect on the other. Thus, it will happen that many important matters will not be so much as named, and that some trivial details will be thrust into places of undue importance.

As neither my knowledge nor your time would admit of a complete discussion of the large subject before us, you will, I trust, pardon the imperfections incidental to my treatment of relationships at once numerous and obscure. And now that I endeavour to place in orderly sequence some of the main features of to-night's subject, I feel perplexed by the difficulty of marshalling my facts. Perhaps my best plan will consist in first offering a kind of conspectus of the contact points on which I wish to dwell. We may set this down, then—

$$\left.\begin{array}{l}\text{Physical Structure}\\ \text{Chemical Composition}\end{array}\right\}\text{virtually inseparable}$$

affect

1. Form,
2. Surface,
3. Colour.

Form is the primary necessity of all good wares. If beauty of form be attained, the eye is satisfied; it demands nothing more. In the entire absence of

decoration, whether of surface gloss or of colour, no want is felt. The satisfaction furnished by beauty of form may be examined critically with advantage, but I do not propose to consider this section of the subject now. I want to draw your attention to the two questions of surface and colour, so far as unglazed wares are concerned, adding here and there a few observations on peculiarities presented by pottery, which, though glazed, owes its significance to the body rather than to the glaze. By taking up in order some of the specimens before us, we shall be able, I hope, to apprehend the illustrations, which such products afford of the physical and chemical qualities of their components. Plasticity, insolubility, contractility, infusibility, and chemical interaction, may be named as included amongst the qualities thus to be noted.

Here is a specimen of common brown earthenware of Japanese manufacture. Three hemispherical cups of different sizes have been attached, when just thrown, by pressure to one another. The way in which their form has been modified by mutual pressure and contact, exhibits at once the tenacity and plasticity of the moist clay. A second example is furnished by this Japanese bottle, which, in lieu of a handle opposite to the lip, has two depressions for finger and thumb on opposite sides—depressions made in the moist clay without breaking the continuity of the fabric. True, such unsymmetrical cavities border upon the grotesque; and so, when workers of better knowledge utilised such capacities of the plastic clay, they added two or more further depressions, seen in many vessels of Greek and Roman origin.

A leaf, modelled from the cypress of Japan, shows the unchangeable character of a refractory clay in the kiln. Upon all the minute and intricate detail of this leaf, has rested for hours the molten glaze, yet the sharpness of every original impress of the mould has remained intact. Neither fusion nor solution has occurred.

The compactness attainable with unglazed bodies is beautifully shown by those specimens of Böttcher ware, which were polished, partially or wholly, and inside and outside, on the lathe. They are of a rich reddish brown hue, and bear a polish as fine as the jasper and basalt wares of Wedgwood, which they antedate by fifty years or more. But this mode of achieving a fine surface is not to be commended. It brings out no device or texture, though it does illustrate a physical property of this ware, intelligible under the microscope. At the high temperature employed in firing Böttcher's red ware, the alkaline matters present have formed a slightly fusible silicious cement, in which the clay of the paste is firmly embedded; the resultant texture approaches that of hard porcelain, and may be justly considered a fine stoneware. Yet, on examining the extant pieces of this ware, often of large size and complex form, one cannot help regretting that so much labour has been bestowed on this compact, but rather uninteresting, body—labour which might have been much more profitably given towards the development of the hidden beauties of some natural hard stone, such as agate or jasper.

Red wares, similar to the Dresden "red china" of Böttcher, were made, at one time, to a large extent in China, and, during the present century, in Japan. Here are half-a-dozen specimens, illustrating easier and more legitimate modes of decoration, than that originally devised by Böttcher. We notice upon these examples ornaments and devices worked in the unburnt ware. The methods employed are four, and we may characterise the several decorations as (1) incised; (2) inlaid; (3) onlaid, or applied; (4) impressed. Should the resources of these methods be deemed insufficient, the ware, after firing, may be adorned with coloured enamels; some beautiful examples of Chinese origin exhibit blue, green, and white enamels, which, by their surface lustre, as well as by their colour, contrast charmingly with the matt or half-dead ground. The so-called Mishima ware of Japan affords further illustrations of the inlaying of one clay with another, and recalls, in a measure, the chief characteristic of the *faïence d'Oiron* or Henri Deux ware. In the East, as in Europe, the range of colours in the body and its ornaments included, besides many shades of red and brown, buff, drab, and yellow.

No ware made in England, save that of John Philip Elers (1693-1710) and of his imitators and successors, quite equalled the "Eastern red dry china," as Wedgwood called the Oriental fabric to which I have been just referring. Wedgwood's own attempts in this direction were not equal to Elers's work, in fineness of paste or tone of colour.

The red tint of the greater number of the wares which I have described brings us to the consideration of its cause. Iron here, as elsewhere in the products of art as well as of nature, is the cause. This metal exists in clays burnt or unburnt in at least six states of combination:—

1. Anhydrous sesquioxide—causing a red or pink colour.
2. Hydrated sesquioxide—yellow or brown.
3. Pyrites—grey or blue.
4. Glauconite—grey-green.
5. Ferric silicate—yellow, buff, or fawn.
6. Magnetic oxide—neutral grey.

But it is not a mere question of the presence of one of these, for often two or more in the same body influence its colour. Through different amounts as well as qualities of iron compounds are the resulting colours influenced—further effects being produced by the several undermentioned conditions or materials:—

a. Heat of greater or less degree.
b. An oxidising atmosphere during burning.
c. A reducing atmosphere; or, carbonaceous matter in the ware.
d. Presence of lime or magnesia.
e. Presence of alkalies.
f. Presence of very fine ferruginous particles.
g. Presence of soluble alkaline and earthy salts.

By the consideration of the states in which the iron existed in the clay, and of the changes wrought by the conditions and materials just named, it is easy to explain and produce at will a very great variety of colour-effects in unglazed ferruginous pottery. Many examples illustrating this fact may be cited. Such are the buff and red terra-cottas of Watcombe, and those made at Copenhagen by Ipsen and Ahrends; the body and decorations of many Greek and Roman vases; the black ware once so abundantly manufactured in

Roman Britain; and a large variety of Japanese products, amongst which the mottled clays of the Imado and Banko wares should be particularly noted. But no better illustrations of the varied functions of iron in earthen bodies can be furnished than those which bricks supply. We have thin Roman bricks burnt right through, and completely oxidised; we have the thicker bricks of to-day, varying between brown and orange, according to their position in the kiln. Then there are the plum-coloured bricks of the Tudor times, and the orange-red of the close of the seventeenth and commencement of the eighteenth century. The sickly yellow bricks, blanched by added chalk, made from the London clay, are a good instance of the curious effect of lime upon ferric oxide, neutralising its redness, and even replacing it by a dull pale green. The Dutch, two centuries or more ago, made excellent impressed bricks, with good ornamental details; some are to be seen still at Walsingham and Ley. And the exquisite terra-cottas of the time of Donatello, still extant in Florence, show what forms of beauty can be realised in common and simple clay. It would be as well for me to draw attention here to the peculiar defective surface that which some terra-cottas exhibit. If one portion has been more compressed than another, or if one part has dried first, there is great probability that the part so pressed or so dried, will be covered, after firing, with a firmly-attached film of irremoveable pale-coloured silicate, formed by the union of calcareous and other soluble salts (present in the water moistening the clay) with silica in the body. You thus get a sickly pallor where it is not wanted, as on the cheeks; while lights appear on edges and in shadows, and distort the modelling.

Thus far, I have spoken chiefly of colour stains of earthenware bodies attributable to iron, and yet I have by no means exhausted the subject, for I have not even alluded to these agate wares of the eighteenth century, made at Staffordshire and at Apt. But I must, at least, mention the coloured clays which Mr. G. Maw and the Campbell Tile Company use so successfully in their encaustic tiles. Here we have the oxides of cobalt, manganese, copper, and chromium tinting the unglazed clays throughout their substance, and yet, in most cases, not modifying the hardness of the body. One of Mr. G. Maw's specimens seems to owe its spangled touches of [illegible] to the partial combination with the paste of minute fragments of pyrolusite.

Leaving for future consideration the characteristic capabilities of many other kinds of earthenware bodies, I may conclude the present discourse with a few words on the subject of texture. Many ingredients may be (and some have been) introduced into a paste or body, rather to influence its texture than its colour. The satiny aspect of wares containing [illegible] minerals, though developed by a glaze, is perceptible without such aid. Laminated and acicular minerals and artificial compounds lend themselves more readily to this end than do substances presenting greater solidity. The difficulty which the association with the clays of dissimilar compounds involves, is due to the unequal expansion and contraction on being heated or cooled, which the different substances suffer. But the Japanese, in the specimens which I brought here to illustrate this matter, seem to have overcome this difficulty, at least, to a considerable extent.

It would be wrong for me to conclude my lecture this evening, without special mention of the kindness with which my request for the loan of specimens has been met. With a single exception, to ask was to obtain. To Messrs. Mintons, of Stoke-upon-Trent, Messrs. G. Maw and Co., of Broseley, the Campbell Brick and Tile Company, and Messrs. Londos and Co., the extensive importers of Oriental wares in London-wall, I must express my large obligation for many of the illustrative examples to which I have been directing your attention to-night.

MISCELLANEOUS.

NOTES ON USEFUL PLANTS.

(*From the Kew Report for* 1879.)

The report on the Royal Gardens, Kew, for 1879, which has recently appeared, contains some notes on the introduction and acclimatisation of useful plants into India and the Colonies, which may be interesting to the readers of the *Journal*.

With regard to those important medicinal plants, the Cinchonas, Sir Joseph Hooker deals firstly with what are known as Columbian barks, namely, those producing the Calisaya of Santa Fé, and the hard Carthagena barks. Both of these are of an extremely valuable kind, and only a few plants remained at Kew at the close of the last year. One of these was sent to Jamaica, from whence the Superintendent of the Botanic Garden reports:—"Our specimen of Carthagena bark is in splendid condition. We have now seventeen well established cuttings, with promise of more." The remainder of the plants were sent to India, and a subsequent report from Calcutta says that they are doing well, and there is every probability that they will soon be successfully propagated.

Regarding the extended cultivation of the well-known species of Cinchona, *C. succirubra*, *C. officinalis*, and *C. micrantha*, reports are given from several centres. Thus, from Assam, Mr. Mann says, with respect to the small patches of Cinchona plantations below Nungklow, in the Khasia Hills:—

"*Cinchona officinalis* appears to be healthy, the other two species (*Cinchona succirubra* and *Cinchona micrantha*) all present a sickly appearance, and most of them have only a few leaves at the extremities of the branches. Both species flower sparingly and form no good seedpods. This condition of the plants is ascribed not so much to the climate and altitude as to the very steep slope and shallow surface soil resting on rock, which does not retain sufficient moisture to suit these plants. The plants of *Cinchona succirubra*, near Jirang, look very much better, and both altitude and situation, as well as the soil in that place, seem to be more suited to this species than in the Nungklow plantations."

From Burma, the report of Major Seaton is not very favourable on the prospects of Cinchona cultivation. The plantations seem to have been made so far back as 1879. He says:—

"'All things considered, the Cinchona experiment does not promise well. The oldest trees dying off, and the trees of very small size flowering and fruiting freely, are only too sure signs that the tree finds itself in a site not adapted to its requirements.' It appears, however, that a Ceylon planter has made inquiries about a grant of land in the neighbourhood. It is possible that with the technical knowledge as to the methods of cultivation of Cinchona, and of obtaining a speedy financial return from it, which have been worked out in Ceylon, a better face may be put upon the experiment in Burma."

At Gadcrif, near the frontier of Abyssinia, *Cinchona succirubra* is said to do well. In Ceylon, it is stated that—

"The enterprise of the planters, and the necessity of obtaining a speedy return for invested capital, has led to much more rapid

methods of harvesting the bark crop being adopted in this island than at the first commencement of the enterprise would have been thought possible. The following statement appeared in the *Ceylon Observer* for September 13th, 1878:—' Over large areas in Ceylon it seems as if *Cinchona officinalis* came to maturity in four and a half years, while if trees begin to show signs of canker or decay at even two and a half years, the bark ought at once to be utilised. Bark of such trees will pay well for the gathering. We once sent to Messrs. Howard a specimen of bark from three and a half years old trees. The verdict was, 'good marketable bark as it stands.' "

From Jamaica, the Superintendent of the Botanic Gardens writes:—

"My chief care at the Cinchona plantation is the establishment of large open air nurseries instead of the glass propagating houses which I found here. I sow the seed under thatched sheds and prick out the plants into beds shaded by ferns. This is a simple inexpensive style, which is universally adopted in Ceylon, but unknown here. I fear that the system of glass houses and propagating and hardening frames has done much to frighten people from trying Cinchona here, and besides [the Government plantations] have never been able to distribute more than a few hundred plants, as they had not enough for their own use. In a few months, by next planting season, I shall have 80,000 which I can conveniently spare, and by the end of the year, possibly 500,000." * * * * "Unless the trees are planted thickly enough to 'bower' the ground, as the planters say, the cost of weeding is nearly £4 per acre per annum. By the third year the trees, if well planted and well supplied, ought to cover the ground and save all subsequent weeding."

In the Mauritius:—

"The Cinchonas have grown but slowly. Few experiments have been made with the plants, owing to more pressing work. The plants planted in the forests at a greater altitude than that of the gardens have not grown satisfactorily, but it is hoped some method of growing this useful plant, which will give beneficial results, may still be hit upon; only it must differ considerably from that of other countries."

From Singapore:—

Mr. Murton (Superintendent of the Botanic Gardens) reports:—"All attempts to grow this here have proved fruitless, but *Cinchona calisaya* and *Cinchona succirubra* are likely to do well at 2,000 feet elevation in Perak."

While from Tinnevelly:—

Col. Beddome reports:—"A few plants were sent from the Nilgiris for trial in this district (1856), and the *Cinchona succirubra* plants were put down at an elevation of about 3,000 feet, in a small clearing in the ghât forests; they have been left entirely to nature, but owing to the moister climate, the growth contrasts very favourable with that of Neddivattum or elsewhere on the Nilgiris. During my last inspection I found one of the larger trees to be nearly 50 feet high; it had three large stems at about one foot from the base, the leaves having, it was said, been broken by a monkey when young."

Regarding the cultivation of Cinchonas in Sikkim, the report of Dr. King, published in the *Journal* for September 3rd last, p. 809, is of a subsequent date to that quoted in the Kew report.

On the subject of Eucalyptus planting, Sir Joseph Hooker reports as follows:—

Seeds of species of this Australian genus are continually asked for, and supplied from Kew. The following notices represent the progress made in the cultivation in various parts of the world:—

Assam.—Mr. Gustav Mann reports:—"*Eucalyptus globulus* is by far the fastest growing species cultivated in the Khâsi Hills, and next to it comes *Eucalyptus rostrata*."

Bengal.—Dr. King remarks:—"The Eucalypti from Queensland give little more hope of success than the more southern species, by the planting of which in the plains of Bengal sanguine people hoped to abolish malaria."

Bombay (Northern Division).—Mr. Shuttleworth reports:—"Seeds of different varieties of Eucalyptus were sown; nearly all failed. A few of *E. rostrata* are surviving."

Bombay (Southern Division).—Col. Peyton reports that the plantations of different species of Eucalyptus do not appear to prosper, and "their numbers are rapidly diminishing." . . "They are weedy and whip-like in growth, and require to be propped up to prevent falling over." Near Dharwar what is supposed to be *E. resinifera* appears to prosper. "Four trees are remakably fine, although only six years old. They have attained on an average 40 feet high, and are five inches in diameter five feet from the ground."

Jamaica.—Mr. Morris reports:—"Of Australian trees the most desirable here is *Grevillea robusta*, which is adapted for nearly all elevations, and stands wind well. The gums *(Eucalpytus)* get very much blown and seldom look well except in clumps, where, for the first four or five years they are sheltered on the outside by other trees."

Saharunpore.—Mr. Duthie reports:—"There are at present upwards of 31 species under cultivation in these gardens." . . . . "The healthy appearance of some of the kinds, and the rapid growth they are making are sufficient reasons for encouraging their extensive cultivation in India." This is in accordance with what is known of the climate of that (extra-tropical) part of India.

Singapore.—Mr. Murton reports:—"When sown *in situ* they seem to thrive fairly well in Singapore, but do not appear to stand transplanting. *Eucalyptus siderophloia*, *E. Baileyi*, and one or two other species are growing well in the nursery."

Zanzibar.—Dr. Kirk informs me:—"The *Eucalyptus citriodora* from Queensland is now in less than two years from seed about 18 feet high, with wide branches."

On the very important subject of fodder plants, the Kew authorities have a great deal of information, as the following extracts will show:—

Guinea Grass (*Panicum jumentorum*).—This, it appears takes the place of all other fodder grasses in Dominica, as it is hardy and requires but little cultivation.

Dr. Imray says:—

"By keeping the lands down and a little manure occasionally, it may be cut down, crop after crop, for many years. I have had a guinea grass piece treated in this way for full twenty years."

Prickly Comfrey (*Symphytum peregrinum*).—From various trials that have been made, it has been shown that this plant, although of great utility as an early fodder crop in cool and temperate countries, is not adapted for cultivation in hot countries:—

Madras.—The Agri-Horticultural Society report:—"Experiments with Prickly Comfrey have failed, the plants which were in the gardens, though receiving rather more than their fair share of attention, having one by one perished."

Saharunpore.—Mr. Duthie reports:—"I do not believe that the conditions at Saharunpore, as regards either climate or soil, are favourable for the profitable cultivation of this plant. At Chajuri it thrives fairly well. Three crops were taken during the year from 35 roots growing 3 feet apart. The average weight of each crop was 30 lbs."

South Australia.—Dr. Schomburgk reports from Adelaide:—"Prickly Comfrey has again been a thorough failure, and it is now a fact that this plant is of little use; at least, on the South Australian plains."

On the Téosinté (*Euchlœna luxurians*), Mr. Woodrow reports as follows from Bombay:—

"*Euchlœna luxurians* produced a heavy crop of forage when treated as a garden plant, but not better than would be given by sugar-cane in the same circumstances. When treated as a fixed crop, under the same conditions as Jowaree, the produce was inferior to that crop."

Queensland.—Mr. Walter Hill reports from Brisbane:—"The seeds received by me were duly planted, and grew both strong and healthy, flowering about the month of May. From the opportunity I have had of judging of its nutritive qualities, I am not of opinion that it can be grown to much advantage in this colony; the stalks appear to be too fibrous and hard to possess much nourishment. I shall, however, make further experiments."

Saharunpore.—Mr. Duthie reports:—"As far as cultivation is concerned, success has been complete. The majority were fine, healthy plants, and an abundant supply of excellent seed was produced."

Singapore.—Mr. Murton reports:—"This grass, although useful, does not bear out its reputation in the Straits. Large quantities of seeds have been distributed, but all accounts from the Native States state that it pays far better to grow maize, as the same ground that will grow Téosinté will produce excellent maize."

South Australia.—Dr. Schomburgk reports from Adelaide that, notwithstanding the disastrous drought of the early part of 1879, "the prevailing dryness did not injure the plants, showing not the slightest effect on their leaves, which preserved their healthy green, while the blades of the other grasses suffered materially. . . . At the Government garden, at Palmerston, in the Northern Territory, the growth of the *Euchlœna* has been surprising. In the course of five or six months the plants reached the height of 12 to 14 feet, and the stems on one plant numbered 56. The plants, after mowing down, grew again several feet in a few days. The cattle delight in it in a fresh state also when dry. Undoubtedly, there is not a more prolific forage plant known. . . . . I can recommend it as a most valuable summer forage plant in our dry climate, especially if it can be planted in a moist soil. The only drawback with us will be that the ripening of the seed crop will be problematical, as early frosts will kill the plant."

The most recently introduced fodder plant is known as the Tagasaste (*Cytisus proliferus var*).

"It is a shrub indigenous to the Canaries, the leafy branches of which are said to be a useful fodder. It requires a light dry soil, and is rather intolerant of frost in winter. The plants should be placed 6 to 10 feet apart, may be cut two or three times a year, and will last 10 to 20 years. Thirty-five pounds of fresh-chopped Tagasaste mixed with 20 lbs. of chopped straw is said to be sufficient for the daily nourishment of a horse or cow. The seed

[illegible] The seed was pretty widely distributed [illegible] It is [illegible] to expect the results of trials [illegible]

[illegible] Most of the seedlings died off after germination. [illegible] of present year :—"At [illegible] looking healthy, and from them I [illegible] be obtained."

[illegible] reports from Adelaide :—"[illegible] The growth of the plant [illegible] having reached 2 to 3 feet. [illegible] affected by the severe [illegible] with. I have many plants [illegible]"

The supply of India-rubber, or Caoutchouc, is a question that has of late years occupied the attention of commercial as well as scientific men. It has received a good deal of attention at Kew, as the following extracts from reports from various parts of the world will show :—

[illegible] Mr Murton reports :—"The plants [illegible] are now large plants, but [illegible] from the strong growths they are making [illegible] whereas they used to propagate freely from [illegible] while in pots."

[illegible] —BURMA.—Major Seaton reports :—"A quantity of seed of this India-rubber tree was [illegible] from the Botanical [illegible] Ceylon, and at the request of Dr. Thwaites, [illegible] to Ceylon to receive instructions in [illegible] India-rubber plants."

[illegible] "The Ceara rubber promises to [illegible] The seedlings received from Kew have [illegible] of them are now 20 feet high. The [illegible] in Ceylon having, at the request [illegible] India, undertaken the propagation [illegible] seeds of it were distributed by him [illegible] the year. Supplies were, I understand, [illegible] in Burmah and Assam, and to [illegible] for Madras. A large supply [illegible] and a thousand seeds were sent, at [illegible] Forests for Bengal, to the officer [illegible] near Chittagong. The seeds [illegible] and I expect before long [illegible] of seedlings for trial in [illegible] The plant appears to thrive very [illegible] quality of rubber yielded by it in [illegible] its introduction may prove of [illegible]"

[illegible] "Ceara Scrap rubber must [illegible] adapted to the climate of the [illegible] invariably rotted off during continued [illegible]"

[illegible] me that with him the Ceara [illegible] but the seeds are slow to [illegible]

[illegible] "At Mergui eight [illegible] the batch of seedlings [illegible] continue to do well in the office [illegible] from 8 feet to 25 feet. . . . [illegible] a considerable number of [illegible]"

[illegible] "Pará rubber, of which 14 [illegible] the date of last report, con[illegible] Most of these 14 plants are [illegible] and it is quite clear to [illegible] can ever be cultivated [illegible] into growing [illegible] thoroughly tropical [illegible] of the climate of [illegible] I believe it is useless [illegible] south of Burma or the [illegible] I learn from Dr. Thwaites [illegible] in Ceylon, there are [illegible] that these are of the [illegible] of which is barely 6 feet [illegible]"

[illegible] "I regret to say that there [illegible] in the garden, one which I [illegible] a vigorous young tree 10 feet [illegible] of 16 plants sent [illegible] but which unfortunately [illegible] Custom house for [illegible] after the voyage, all [illegible] conditions of this dis[illegible] cultivation of [illegible]"

[illegible] "The Pará rubber is a less quick [illegible] It is 10 feet high."

Like India-rubber, Liberian coffee, about which so much was [illegible] a few years since from [illegible] into many of the British Colonies, has received a considerable amount of attention in the present report. In Burma it is said to be thriving, and showing signs of flowering, so that it is hoped some opinion of the economic value of the coffee may soon be known.

From Dominica, the late Dr. Imray wrote as follows :—

"I am glad to say that the Liberian coffee cultivation may now be fairly considered as established in this island. The fine, healthy, luxuriant trees on my small plantation, with a crop of berries on many of them, afford sufficient evidence of the climate being congenial to the plant. The cultivation is successful, and only awaits extension by others taking it up. I have several thousand seedlings planted out in the open, and thriving well. I lost a good many seedlings, however, by putting them out when too small. To ensure their rooting they should be pretty well grown before they are transferred to the field. Protection of some kind or other is also advisable at first, as well from the scorching rays of the mid-day sun as from strong winds. When fairly rooted and growing, the plants are hardy enough, and will bear a good deal of exposure and neglect."

Dr. Imray further remarks on the coffee-leaf disease of Dominica (*Cemiostoma coffeellum*), which had succumbed in clearing off the old *Coffeea Arabica* plants, but which it was hoped would not find a resting place on the new plants, that it really had attacked the plants in their very young state, and only on the cotyledonary leaves. The leaves were cleared by killing the larvæ, and brushing off the chrysalis wherever it appeared; after this the seedlings steadily increased in size, throwing out fresh leaves, after which most of them were planted out in the field, and were thriving well, with not a speck of the blight on them. Dr. Imray says :—

"This, however, is not the only attempt the insect has made to gain a footing on the Liberian coffee. On carefully examining the large trees some six or eight months ago, a few leaves were found where the insect really had established itself, but in a very feeble manner. Some of the larvæ were lively enough, but others small and weak, and the skeletons, if I may so speak of others that had died, were found in the brown patches of the leaf, when the upper and under cuticle were separated. Very few cocoons were observed, and these were smaller than usual."

This report from Dominica, which is given in extenso in the Kew report, concludes with advice as to the absolute necessity of protecting the seedlings from the ravages of the white fly, without which protection very few of the plants will be saved.

In Jamaica it seems there is a great demand amongst planters for this kind of coffee, but attempts on the part of private persons to import either plants or seeds have failed. The plants, however, in the Jamaica Botanic Garden, have ripened their seeds, which have been sown to increase the stock.

From Seychelles, Mr. E. S. Salmon, the Chief Commissioner, writes :—

"About 150 plants of Liberian coffee—mostly raised from seed you sent—have been planted at Mahé Island, at elevations varying from the shore to 1,500 feet above sea-level. It comes best, apparently so far, in the open without shade. One plant, at an elevation of about 300 feet, without any shade and close to a granite rock giving out considerable heat, has about 100 strong looking flowers on it. This plant is 18 months old."

From Singapore :—

Mr. Murton reports :—"The Arabian coffee here is severely attacked by the disease (*Hemileia vastatrix*), which has destroyed all hopes of our being able to supply seeds for planters in the Peninsula. The Liberian coffee has not yet shown any signs of being attacked, although some Perak planters have been scared by yellow blotches on the younger parts of the branches." (They appear to have no connection with the disease.) "The species is evidently very impatient of deficient drainage. The plants raised from seeds received from Kew in May, 1878, are now blooming profusely. Eight hundred fruits from our plants have been sent to Government Hill, Penang, and 500 sent to Perak. Very favourable reports have been received from the Native States regarding the progress of the plants of this species there, and there can now be no doubt that the Liberian coffee has found a congenial home in the Malay Peninsula and adjacent islands, and its future propagation may now be left to planters."

In Queensland, Liberian coffee is said to have become thoroughly established on the Herbert river, where it promises to attain complete success; while from Zanzibar the plants are reported to be in flower.

On the subject of mahogany cultivation in the Old World, Sir Joseph Hooker writes as follows:—

"This may now be regarded as an accepted success. The tree grows well in many parts of India and in Ceylon, and in the former there is a local demand for the wood. In this country new uses are found for it, one of the most recent being for the linings and panellings of railway carriages instead of teak, which is now exclusively used for ship building. It is not easy to see any valid arguments against the cultivation of a tree, the timber of which is of admitted excellence for a variety of purposes, and the growth of which is apparently attended with little difficulty. As late as 1876 the Government of Bengal was adverse to mahogany planting. This policy has now, however, been modified, and in his report for 1878-79, Dr. Brandis, the Inspector-General of Forests, reports:—'Of the exotic trees which are cultivated by way of experiment, mahogany is the most important, and its success seems not improbable, though it is too early yet to form final conclusions upon the subject.' Mahogany is also cultivated as an experiment in Burma and the Chittagong district of Bengal. The tree is known to thrive well near Calcutta, and every effort should be made to cultivate it in those forest districts where climate and other circumstances are favourable."

From Bombay, Burma, Saharunpore, and Singapore favourable reports have been received of the cultivation of mahogany, while in Queensland, seeds have been distributed for sowing.

Under the head of "Food Products," attention is drawn to the desire of the Indian Government to introduce the *Arracacha esculenta*, a South American plant, producing an edible root. A reference is also made to the use of the chestnut as an article of food in the Apennines. Cakes made from chestnut-flour which had been presented to the Kew Museum were found upon analysis by Professor Church to contain over 40 per cent. of nutritious matter soluble in pure water. Professor Church thinks, therefore, that chestnut-flour should be an easily-digested article, and suitable for children's food. A good deal of consideration is given to vegetable fibrous substances suitable for paper-making, besides textiles and useful and ornamental woods. The length of these notes, however, precludes any detailed notice of these substances.

INTERNATIONAL WOOL EXHIBITION FOR 1881.

An official report on the American textile industries of Philadelphia has been received from the Foreign Office by the Directors of the Crystal Palace.

The wool trade of the City of Philadelphia is very large. Nearly one thousand mills are kept running on textile fabrics, employing over 100,000 persons, and producing thirty-one millions sterling of woollen, worsted, cotton, and silk manufactures per annum. The sales of wool for manufacture in Philadelphia and its environs amounted, for the year ending April 1st, 1880, to 100,000,000 lbs., and the production of manufactures, consisting of fine woollen and worsted yarns, carpets (worsted and wool), clothing, blankets and fibrous woollens, hosiery and knitted goods, amounted to £15,416,000. The wool production in the United States amounts to 300,000,000 lbs., and the manufacture therefrom is equal in value to one dollar per pound of wool. The annual importation of wool is from 30,000,000 lbs. to 50,000,000 lbs. Thus there is a manufactured production from the wool growth and importation of £70,830,000 for the United States.

The consumption of cotton in the manufactures of the American Republic is equally remarkable. About one-fourth of the American crop is consumed in Pennsylvania, 1,500,000 bales of the annual crop having been already taken by the Philadelphia spinners. Of the crop of 1879, which was 5,200,000 bales, the exports were 3,826,226 bales (up to August 25th, 1880), and the consumption in America, 1,125,000 bales. The crop of this year, so far as the returns of the gathering have come in, amounts to 5,760,000 bales, which, at £9 5s. per bale, figure up a value of £53,280,000. One-fourth of this product, manufactured in Philadelphia, shows an industrial total of £13,320,000. The wool production for 1880, is estimated at 300,000,000 lbs., at a value of £1,875,000, and the exportation of 65,000,000 lbs., valued at £406,200, added thereto, give a stock for manufacture in the States, equal to £62,000,000 of manufactured products thereof.

The manufacture of three textile articles in the United States can safely be placed thus for the year 1880:—

	Dollars.	£.
Cotton	250,000,000	52,000,000
Woollens....	300,000,000	62,000,000
Silks	30,000,000	6,200,000

The leading American manufacturers have expressed their willingness to take a prominent part in the forthcoming Exhibition, by showing wool, woollen manufactures, and machinery.

A large number of applications have also been received from British engineers and machinists for space to exhibit machinery in motion, and a committee of advice, consisting of official representatives of the Colonies, and foreign States, and gentlemen interested in International Exhibitions, has been formed.

TECHNICAL MUSEUMS.

A paper was read by Mr. Alderman W. H. Bailey, on "Technical Museums and Libraries," at a late meeting of the Scientific and Mechanical Society, Manchester. He said:—"If it be proper to establish free libraries for the benefit of the people in order that general knowledge may be acquired, it seems but reasonable that if it can be shown that there are certain trades on which the bulk of the people of a town are dependent for bread, and that full knowledge of those trades can only be imparted by means of models and drawings, that it is quite as legitimate to have free trade or technical museums as free libraries; the sole object being in both cases to increase the prosperity of those who pay the public rates. Foreign competition is becoming keener every day, and we must recollect with all seriousness that we have not always been the leaders in manufactures; indeed, before the invention of the steam-engine it would be difficult to name any great industry in which we were superior to other nations. The Dutch, the Spaniards, and the French and Italians were infinitely superior to us, and when all the world become proprietors of steam-engines, which is an exaggerated way to put the question, only those who can use the forces of Nature with the highest wisdom will be able to be first in the race. To the members of a Society like this it requires very little argument to illustrate the value of models and drawings over mere descriptions of machinery or processes. Our great inventors at the commencement of this century have nearly all been men of ancestral power—some call it natural ability in contradistinction to that ability obtained by education—and by that high skill called culture, these men, not having much to do, made single great discoveries. I say this because there exists a popular delusion that inventors very often are lucky guess-work men, who have been accidentally successful. My experience of men who have risen to positions as foremen and managers is that they have their positions because of their integrity, industry, and, to use the phrase again, natural ability. This class of leaders in our works are the very pick of the working classes, who have risen to their positions by reason of the qualities I have named, and it is for such who thirst for knowledge, as I know they do, and for young men who wish to aspire to similar positions, that I would advocate the establishment of technical museums. Now, what is wanted is a

museums in which first principles can be illustrated by means of models and sectional drawings. Let me speak with some diffidence, when I recommend that the cases of stuffed birds which exists in our museums be removed, and that their places be filled with objects of greater interest to those engaged in the trade of the district." The reader of the paper proceeded to state that in his opinion, the museum should consist of models as well as books, that it should be a technical museum and library, the models should be of interest to those engaged in the trade of the district, and each district would of course require a different style of museum. One at Halifax would be different to one at Bolton. The various industries, silk, cotton, flax, wool, being too vast for one museum, it would be less costly and more beneficial to let each have its speciality. The science examinations, the Whitworth scholarships, and the whole educational work of the country all do good work, indeed, far better work than had ever been done in this country before, but a great deal yet remains to be accomplished in every direction.

COLOUR RELATIONS OF METALS.

In a paper on the colour relations of copper, nickel, cobalt, iron, manganese, and chromium, lately read before the Chemical Society, Mr. T. Bayley records some remarkable relations between solutions of these metals. It appears that iron, cobalt, and copper form a natural colour group, for if solutions of their sulphates are mixed together in the proportions of 20 parts of copper, 7 of iron, and 6 of cobalt, the resulting liquid is free from colour, but is grey and partially opaque. It follows from this that a mixture of any two of these elements is complementary to the third, if the above portions are maintained. Thus a solution of cobalt (pink) is complementary to a mixture of iron and copper (bluish green); a solution of iron (yellow) to a mixture of copper and cobalt (violet); and a solution of copper (blue) to a mixture of iron and cobalt (red). But, as Mr. Bayley shows, a solution of copper is exactly complementary to the red reflection from copper, and a polished plate of this metal viewed through a solution of copper salt of a certain thickness is silver white. As a further consequence, it follows that a mixture of iron (7 parts) and cobalt (6 parts) is identical in colour with a plate of copper. The resemblance is so striking that a silver or platinum vessel covered to the proper depth with such a solution is indistinguishable from copper.

There is a curious fact regarding nickel also worthy of attention. This metal forms solutions, which can be exactly simulated by a mixture of iron and copper solutions, but this mixture contains more iron than that which is complementary to cobalt. Nickel solutions are almost complementary to cobalt solutions, but they transmit an excess of yellow light. Now the atomic weight of nickel is very nearly the mean of the atomic weights of iron and copper, but it is a little lower, that is, nearer to iron. There is thus a perfect analogy between the atomic weights and the colour properties in this case. This analogy is even more general, for Mr. Bayley states that in the case of iron, cobalt, and copper, the mean wave length of the light absorbed is proportional to the atomic weight. The specific chromatic power of the metals varies, being least for copper. The specific chromatic power increases with the affinity of the metal for oxygen. Chromium forms three kinds of salts. Pink salts, identical in colour with the cobalt salts; blue salts, identical in colour with copper salts; and green salts, complementary to the red salts.

Manganese, in like manner, forms more than one kind of salt. The red salts of manganese are identical in colour with the cobalt salts, and with the red chromium salts. The salts of chromium and manganese, according to the author, are with difficulty attainable in a state of chromatic purity. He thinks these properties of the metals lead up to some very interesting considerations.

PRODUCTION OF BRICK TEA IN HANKOW.

The Commissioner of Customs at Hankow reports that the importance of the brick tea trade is rapidly increasing, and the demand becoming greater than the supply. The employment of steam machinery for pressing the bricks has proved in every way a great success, the steam-pressed brick being much better finished than that produced by hand, and more compact and firm, withstanding the difficulties of transit better, and ultimately arriving at its destination in Siberia little, if any the worse, for its journey. With the old method, the bricks, from insufficient pressing power, were liable to chip and crumble at the edges; and as great stress is laid on the perfect appearance of the brick by the Siberians, it can be easily understood that a hard, sharply defined brick would at once obtain the preference. With both methods of manufacturing brick tea there is a drawback, and a serious one—the damping of the dust by steam, which robs it of all its fragrance. To remedy this defect a firm has imported an hydraulic press, which turns out small corrugated-shaped cakes, weighing a quarter of a pound each, retaining the original aroma in all its freshness. There has not, says the Commissioner, been sufficient time yet to ascertain whether the compressed tea will prove a success or not, but samples sent to Siberia have been favourably reported on; and as the improvement of the ordinary brick was so quickly recognised, it is expected that similar popularity will attend the latest experiments. The two kinds will probably run side by side in friendly competition, as the brick will keep its own position for use among the masses, and the compressed tea will become popular amongst the better classes, and if really fine dust be employed in its manufacture, it may, from its portableness and cheapness, generally take the place of the leaf tea at present annually sent overland from Shansi. The following is the method of producing the brick tea. There are at present six manufactories in Hankow, in three of which boilers are used either for steaming the tea, or both for that purpose, and furnishing power for pressing. The dust from which brick tea is made comes principally from Ningchow in Kiangsi, and Tsung-yang and Yang-lout'ung, in Hupeh, and varies both in fineness and cost, according as it belongs to the first, second, or third crop. From four to ten taels is the average cost. The first operation is to sift the dust and reject all the sand and rubbish contained in it, usually amounting to about 5 per cent. It is then placed in a winnowing machine having three different sized sieves, with troughs corresponding, and passed into baskets. The residue which is too coarse to pass any of the sieves is taken out and trodden until it is reduced to the proper consistency, when it is placed in iron pans over a charcoal fire until it is sufficiently brittle, when it is again taken to be winnowed, and this operation is repeated until all has been sifted to the requisite degree of fineness. Three sizes are produced, the coarser ones being employed to constitute the brick, while the finest dust is only used as a facing. The dust having been properly sifted, the next step is to prepare it for pressing, and this is done by exposing it to the action of steam for three minutes, and it is this steaming that robs brick tea of its scent and flavour, and for which a remedy is eagerly sought. The old fashioned apparatus of native design consists of six iron boilers heated by charcoal, and having spaces over which are fitted with rattan covers. When the dust is to be steamed, it is spread out on a sheet of cotton

cloth placed over the boiler and covered up; but with the improved European apparatus the dust is simply put into iron boxes and the steam then passed through them. After having been sufficiently steamed to make it adhesive, the dust is put into a strong wooden mould (on the moveable cover of which the trade mark of the "hong" or firm is engraved, so as to leave the corresponding impression on the brick) and firmly wedged down. It is then pressed and placed on one side for two three hours to cool. Each brick should weigh one catty, and all those that do not come up to the proper standard of weight, or are defective in any way, are rejected and re-made. For this purpose they are taken to a rotatory mill, constructed of two heavy circular stones, moved by a horizontal wooden bar, and working in a channel where the condemned bricks are thrown, and crushed as the wheels pass over them. Having again become dust, the operation already described is, in all its details, repeated. The hand press turns out sixty baskets a day, with 25 per cent. of failure bricks, while the steam press produces eighty baskets a day, with only 5 per cent. of bad work, and the saving, by the employment of the improved machinery, amounts to one tael a basket, or, according to the above stated out-turn, eighty taels a day, or about £20 sterling. The bricks found to be correct in weight and free from defects are stored in the drying-room for a week, when they are carefully wrapped separately in paper, and packed in bamboo baskets containing sixty-four bricks each. Green brick tea is made in the same manner, but of leaf, not dust, and the bricks are larger, weighing two pounds and a-half each, thirty-six going to a basket when packed for export. During the past year only two factories in the interior, at Tsung-yang and Yang-lout'ung, were kept working, and it is expected that in a short time, the whole trade will be transferred to Hankow, to the benefit of its position as a commercial centre, and to the general interest of those connected with it. In addition to brick tea proper, there is also another kind of tea called "medicine tea," which is composed of coarse leaf and stalks, mixed with various kinds of medicinal herbs, and packed in bundles weighing sixty-four catties. It is valued at five taels per picul, and in the event of the cost of transhipment to Central Asia *vid* Tientsin, instead of as hitherto from Shansi, proving sufficiently low, it is expected that the trade will receive ncreased attention.

Owing to the immense quantities of brick tea now arriving at Tientsin for transport overland, it is both more difficult and more expensive to obtain sufficient camels, than it was a year ago, and it is anticipated that the sea and river route *vid* Tientsin and the Amoor will soon be substituted as a necessary consequence of the growing magnitude of the trade.

CORRESPONDENCE.

INTERNATIONAL INDUSTRIAL CONGRESS, BRUSSELS.

In a recent number of your *Journal*, I find the report of the last Congress of Industry and Commerce (Vol. xxix., p. 29). In this report, which I consider very good indeed, you omit to mention what led to the important proposition I put forward, and which was unanimously carried. The following is taken out of the *Echo du Parlement*, and shows what took place on the 9th September last:—

"Mr. Splingard said that the question of an industrial teaching was one most interesting for the Belgian people, and was in close connection with teaching in general. What the German speaker had asked, could only be resolved in a Congress where questions of general teaching as well as trade-arts were discussed. In all civilised countries of Europe, we find a succession of studies through which learners are bound to go to obtain a good education.

"Is the case similar in the teaching of industrial arts? Indeed, a great difficulty arises here. Some industries can not be taught; for instance, the working of coal pits and the manufacturing of iron. In these cases, it would be desirable that such large establishments should be open to students, through some general concert between the employers; some of them have so been opened. There are also the different manufacturing industries, in which it is necessary to join to the workshop a school of apprentices. Practical people ought to make the distinction, and the men of industry are the best judges. But should they fail to fulfil their part, the State would then but fulfil its duty by opening industrial schools.

"The Government would have to recognise that industrial teaching is a question of public utility, and that, in case a part of the country requires it, a subsidy ought to be voted for such new schools. The industrial schools, with the workshops in connection, ought to be considered as objects of public utility."

Will you insert these few lines in your next number. Your previous report will gain in precision, and you will oblige me, as I admit I attach a great value to the question of industrial teaching.

Pierre Splingard,
Membre du Conseil Provincial du Brabant.
5, Place de l'Industrie, Brussels.

SIGNALLING BY MEANS OF SOUND.

In my paper on the above subject, I have unintentionally done an injustice to Professor F. H. Holmes, by giving the credit of certain new forms and applications of siren instruments to Messrs. Sautter, Lemonnier and Co., of Paris (see p. 75). I beg leave, therefore, to be allowed to correct my error, and to express my regret that the source from which I obtained the particulars in question was inaccurate.

Professor Holmes now informs me that Messrs. Sautter, Lemonnier and Co. have simply manufactured instruments from his designs; that the double siren is his invention, and was patented by him in 1875; that the siren arrangement for locomotives is also his design, and was placed in Messrs. Sautter's hands for manufacture.

I am anxious for the insertion of this letter, as I should indeed be sorry that a gentleman who has given so much attention to the subject, and worked so meritoriously in connection with it, should, in any way, suffer from any misrepresentation on my part.

I should like, at the same time, to state, with reference to my remark, that the results of the South Foreland experiments "are stated at length in the third edition of Dr. Tyndall's book on 'Sound,'" that the results are given at length in the "Philosophical Transactions" for 1874, and are concisely stated in Dr. Tyndall's book. E. Price Edwards.
Trinity House, London, 21st December, 1880.

SEA SIGNALS.

In Cliffe's "Book of North Wales," 1850, p. 118, it is stated "that this coast (Anglesea), is the resort in the breeding season of sea-birds, gulls, &c. No one, by order of Government, is allowed to shoot the birds, as in foggy weather they are invaluable to steamers and shipping, being instantly attracted round a vessel, or induced to fly up screaming by the firing of a gun. Captain Skinner's mail-packet was once saved in this way. The birds deposit their eggs in vast numbers on

the south side of the Stack rock, and are then tame. The gulls assemble here on the same night, on or about the [illegible] of February, when they make a great noise, and nearly all retire about the 12th of August." The Ailsa Craig, Bass Rock, and Skerries, are notable for sea-birds, now legally protected, and useful for sea signals. Their wholesale destruction is not only wanton, but mischievous.

CHRISTOPHER COOKE.

London.

OBITUARY.

Frank Buckland.—Although he was not a member of the Society of Arts, the death of this well-known naturalist, on Sunday morning, 19th inst., will be deeply regretted by a large number of the members, who have always appreciated his appearance at the meetings of the Society. Francis Trevelyan Buckland was the eldest son of the Very Rev. William Buckland, D.D., Dean of Westminster. He was born on the 17th December, 1826, and was educated at Winchester and at Christ Church, Oxford. Having studied medicine in Paris and London, and served as house-surgeon to St. George's Hospital, he entered the 2nd Life Guards in 1854, as assistant-surgeon. He left the army in 1863, and for a time was a constant contributor to the *Field* newspaper and other periodicals. In 1866, with the late W. Pennell, the first Inspector of English Salmon Fisheries, Mr. Buckland projected and started *Land and Water*. He conducted its intelligence in regard to sea and river fisheries and practical natural history, and contributed to it up to the very day before his death. In 1867, Mr. Buckland was appointed Inspector of English Salmon Fisheries, and his advice was sought by the Governments of Russia, Germany, France, America, &c., as well as by our colonies. In 1868, Mr. Buckland gave evidence before the Food Committee of the Society, and served on the Piscicultural Committee in 1869. In [illegible] he was appointed Special Commissioner for the Salmon Fisheries of Scotland. He published a report on the Norfolk fisheries, which led to the Norfolk and Suffolk Fisheries Act of 1877. In the same year he was one of a Commission to inquire into the crab and lobster fisheries of England and Scotland, which resulted in an Act of Parliament for the protection of those [illegible]. In 1877, he also served on a Commission of inquiry into the herring fisheries. In the next year he was engaged upon the Commission relative to the sea fisheries around England and Wales, a report upon which was published last year by Mr. Buckland and Mr. Spencer Walpole. The first paper contributed by Mr. Buckland to the Society, which was on "The Acclimatisation of Animals," was read on November 28th, 1860, and the last occasion on which he presided at a meeting was on April [illegible], 1879, at the reading of Mr. Willis Bund's paper on "English Fresh Water Fisheries." He was then in feeble health, and was forced to leave the chair on account of illness. His Juvenile Lectures on "Birds, Beasts, and Fishes," in 1873, most successfully commenced these annual series of Christmas lectures.

GENERAL NOTES.

Royal Institution.—The lectures for the Friday meetings, before Easter, 1881, are arranged as follows:—January 21st, Warren De La Rue, Esq., D.C.L. F.R.S., Sec. R.I., "The Phenomena of the Electric Discharge, with 14,400 Chloride of Silver Cells." January 28th, Dr. Andrew Wilson, F.R.S.E., "The Origin of Colonial Organisms." February 4th, Dr. Arthur Schuster, F.R.S., "The [illegible] of the Stars." February 18th, Sir John Lubbock, Bart., M.P., D.C.L., F.R.S., "Fruits and Seeds." February 25th, Dr. J. S. Burdon Sanderson, LL.D., F.R.S., "Excitability in Plants and Animals." March 4th, Sir William Thomson, LL.D., F.R.S., "Elasticity Viewed as Possibly a Mode of Motion." March 18th, William H. Stone, M.D., "Musical Pitch and its Determination." March 25th, Alexander Buchan, M.A., F.R.S.E., Sec. Met. Soc. Scot., "The Weather and Health of London." April 8th, Prof. Tyndall, D.C.L., F.R.S. The lectures for March 11th and April 1st are not yet fixed. Prof. Dewar will give the first of his Christmas Lectures (adapted to a juvenile audience) on "Atoms," on Tuesday next, December 28th, at three o'clock, at the Royal Institution.

Trans-Australian Railway.—The colony of Queensland seems likely, according to *The Colonies and India*, to be the first to put into practical execution the long-cherished hope of a trans-Australian railway, which shall connect the northern with the southern shores of the island continent, and bring the colonies within 30 days of England, making those which are now practically most distant from Europe the nearest in point of time, as they are by right of geographical position. The original route proposed for the trans-Australian railway was from Port Augusta in South Australia to Palmerston, the central port of the northern coast, adopting generally the line passed through by the existing overland telegraph. The distance to be traversed in a direct line from the northern terminus of the South Australian Railway to Palmerston is 1,400 miles, and considerable connecting links would have to be constructed between the existing lines in the adjoining colonies to complete direct communication between Port Augusta and Melbourne and Sydney. By the new route now proposed, and, in fact, finally adopted by the Queensland Government, the following advantages are secured. The principal railway from Brisbane has just been completed in a north-westerly direction to Roma, a distance of 317 miles, and from this point to the nearest part of the Gulf of Carpentaria on the north coast is, in a direct line, barely 850 miles. The line would almost touch on its way the important railway from Rockhampton to Emerald-town, and the blanks to be filled up in the existing lines between Brisbane and Sydney are no greater than the links required to complete the chain between Adelaide and Sydney. If these latter are completed, there will be, on the completion of the now projected line from Roma to the Gulf of Carpentaria, continuous railway communication between the northern and southern coasts of Australia, having the additional advantage of traversing the whole of the most settled districts, and connecting all the principal cities, except those in Western Australia. The Queensland Government has passed an Act authorising the construction of the trans-continental railway, and a syndicate has already agreed to perform the work, on the condition of receiving, among certain other privileges, an area of 8,000 acres of land for each mile of railway constructed.

French Fruit and Vegetable Trade.—M. Joly gives some statistics, in a recent number of the *Journal* of the Central Horticultural Society of France, relating to the importation of fruits and vegetables into France in the years 1877, 1878, and 1879, as well as to the quantities exported in the same years. The number of kilogrammes of oranges and lemons imported amounted in round numbers to 37,000,000 in 1877, 34,000,000 in 1878, and 37,000,000 in 1879, Spain furnishing by far the largest amount. Of other fresh fruits the importations were 5,000,000 kilogrammes in 1877, 7,000,000 in 1878, and 15,000,000 in 1879. Italy and Belgium supplied the largest proportion, but there is also a considerable exportation of this class of fruit from England, amounting to 362,000 kilogrammes in 1877, to 107,000 in 1878, and to 42,000 in 1879. 4,000,000 kilogrammes were exported from Italy into France, or double the amount of the preceding year. As to the exportations from France, the quantities of oranges and similar fruit amounted in 1877 to nearly 4,000,000 kilogrammes, in 1878 to nearly 3,000,000, and in 1879 to 2,500,000 kilogrammes. Of other fruits the total amounts exported from France to England were, in 1877, upwards of 19,000,000 kilogrammes, in 1878 upwards of 24,000,000, but in 1879 only 13,000,000 kilogrammes. Of potatoes, the quantities exported from France into England were, in 1877, upwards of 103,000,000 quintals, in 1878, more than 107,000,000 kilogrammes, and in 1879, 84,000,000 quintals.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

JUVENILE LECTURES.

The first of these lectures, on "Animal Intelligence," was delivered by Mr. G. J. Romanes, F.R.S., on Wednesday evening, 29th inst. The lecturer devoted the whole of his lecture to the consideration of the habit of Ants, and arranged his subject under the following seven heads:—I. Sense of sight, hearing, and smell. II. Sense of direction. III. Power of communication. IV. Powers of memory. V. Affection and animosity. VI. General habits. VII. General intelligence. Each of these divisions was illustrated by anecdotes, related on the authority of trustworthy observers, such as Huber, Lubbock, Belt, Bates, Lipscomb, Moggridge, and others. The second lecture will relate to the intelligence of the higher animals.

CANTOR LECTURES.

SOME POINTS OF CONTACT BETWEEN THE SCIENTIFIC AND ARTISTIC ASPECTS OF POTTERY AND PORCELAIN.

By Prof. A. H. Church, M.A. Oxon., F.C.S.

Lecture II.—Delivered November 29th, 1880.

Glazes, Enamels, Iridescent and Metallic Lustres, and Colouring Substances.

From the form, texture, and colour of unglazed wares—whether the body be merely drawn together by heat, as in the softer terra-cottas, or whether it be more or less vitrified, as in the "red opaque china" of Böttcher and Elers, and the black basaltes of Wedgwood—from considering the decorative elements of the bodies, we pass naturally to the various modes of enriching the surface which glazes and enamels supply. We shall understand this part of our subject more thoroughly, if we classify the constituents of all ceramic wares, not of the glazings and slips only, but of the bodies also, somewhat after the following fashion, noting the characteristic property which each separate constituent does, as a rule, confer upon the product to which it has been a contributory:—

i. *Refractory.*	ii. *Hard.*	iii. *Fusible.*
Alumina.	Silica.	Lead oxide, Potash, Soda, Boracic acid, Lime, Baryta.
iv. *Colorant.*	v. *Lustrous.*	vi. *Opaque.*
Iron, Copper, Cobalt, Manganese, Chromium, Antimony, Nickel, Uranium.	Gold, Platinum, Silver, Bismuth.	Barium sulphate, Bone-ash, Binoxide of tin.

But no sharp distinction can be drawn between these six classes, if we include in our view all possible combination of them one with the other; or if, on the other hand, we exclude completely from a ceramic composition one or more of the chief members of the first three classes. Lime, for example, usually aids in the fusibility of a body or glaze, forming with silica a silicate, which melts without difficulty. But nothing—not even alumina—is so refractory as pure lime, from which crucibles for use with the oxy-hydrogen blowpipe, and for the fusion of platinum, are made. Again, iron is set down as giving colour, but it unites with silica and small quantities of lime or alkaline oxides to form a kind of half-glaze. This Japanese bottle shows three conditions of surface on unglazed brown stoneware; a surface on which an iron ore, containing nearly 90 per cent. of oxide of iron, has been spread; and a region near the mouth, to which some small sprinklings of felspathic clay have been further added. The gloss of the three surfaces has been progressively increased, while the microscopic examination of the glazed portions indicates the cause of the beautiful colours and textures which have been formed. One of the crystalline kiln-products thus formed within the glaze is a copper-coloured complex ferric silicate, which is a very common constituent of ferruginous glazes. Some bricks offer instances of such iron glazes, often produced irregularly and accidentally. The so-called Samian ware, with its sealing-wax red glaze, and the black Greek vases, show what colour effects are producible by fine compositions rich in iron.

In studying the relations of glazes and enamels to the decorative effects which they produce, it will be useful to consider these three qualities:—

(*a.*) Transparency, translucency, or opacity.

(*b.*) Colour, whether below, in, or above the glaze; its distribution; its quality.

(*c.*) Lustre; its quality and position.

Keeping these points in view, it may not be without use if I give you a brief account, arranged in some sort of chemical, historical, and artistic sequence, of the chief glazes and allied preparations, which we must consider if we would properly

understand the decorative results achieved by their use.

Soda Glazes.—Although early felspathic glazes owe their vitrescence to potash or soda, yet the alkaline glazes from "natron," the native carbonate of soda from Egyptian soda-lakes, from the mixed potash and soda salts of burnt seaweed, and from the potash salts of burnt land-plants, are earlier in date. Babylonian and Assyrian enamelled bricks (*circa* B.C. 700 — 600) contain, like those of Egyptian origin, silicate of soda as the basis of the glaze, with copper, iron, antimony, and even lead for colouring (the last for increasing the fusibility also). Old Indian enamels, dating at least from the thirteenth century of our era, contain a silicate of soda and copper, yielding a fine turquoise colour, and also another soda silicate, tinted by oxide of cobalt. Soda glazes, when not too alkaline, possess the merit of being unaffected by the water, the carbonic acid, and the sulphuretted hydrogen, which, singly or conjointly, tend to disintegrate, or at least to roughen and tarnish, many glazes containing lead. And it is by the aid of soda alone that certain hues, as that of the turquoise, can be developed.

Potash Glazes are mainly those which are formed from felspar and from china-stone, which contains both felspar and immature kaolin, from which by no means all the alkali has been eliminated. Of these glazes I shall have something to say further on in the course, when speaking of hard porcelains. But potash glazes, properly so-called, can hardly have originated otherwise than by burning land-plants with or on sand, by which glass, the typical glaze, was first produced.

Lead Glazes can, in England, be traced back to the first or second century. Several Roman lamps show a green glaze, containing much lead, coloured by iron and copper; one found at Dorchester, Oxon, is in my collection. All the early mediæval tiles in which England excelled are glazed with lead. Litharge (PbO), red-lead (Pb_3O_4), white-lead ($2 PbCO_3 . PbH_2O_2$), and lead glass were all, and are all, employed; to these materials must be added galena, the native sulphide of lead. A previous "fritting" of the plumbiferous substance is advantageous: first, in order to secure the combination of the lead oxide with the china-stone, flint, or other siliceous materials of the glazing mixture; second, to allow of the lead being lowered to a minimum amount; third, to increase the hardness and insolubility of the glaze. Lead certainly developes (as does zinc oxide also) the beauty of some of the enamel colours, and it would be hard to exclude it from all glazes, although borax and boracic acid, the chemical function of which is different, may replace it to some extent, and in many instances. Two marked peculiarities belong to lead glazes—one of these is the yellow tint (fused lead protoxide and highly plumbiferous silicates are yellow), which glazes containing much lead give to white clays, an effect seen on many early tiles and other specimens of early English pottery; and the other peculiarity of lead glazes is the iridescence, often beautiful, caused on their surface by their commencing decay.

Tin Glazes, often called enamels *par excellence*, owe their gloss, generally at least, to lead, the tin binoxide merely imparting whiteness and opacity. Babylonian and Assyrian specimens are known, but the use of tin seems to have been local at all times, and the lack of acquaintance with its properties, or perhaps rather of the opportunity of securing a supply, seems to have caused a cessation of its employment. The tiles of Mahomet's tomb (A.D. 707) contain neither lead nor tin. But stanniferous glazes were introduced into Spain by the Moors in the thirteenth century; they are found in Italy as early as 1400. There is great danger of hardness and coldness when tin glazes are painted upon; a subsequent transparent glaze has been used to obviate this defect; but they are adapted for highly pictorial and precise work. A drawback lies in the ease with which these tin glazes may be detached from the porous bodies to which they are usually applied. This tin enamel often contains too much tin oxide—sometimes twice as much in the newer than in the older specimens. One consequence of the difference is seen in the way in the colours lie on the surface when it is rich in tin, but in the opposite case they work into the ground during firing, and so produce a softer effect. For works in basso and alto relievo one would have said that tin glazes were ill-adapted, had it not been for the works executed in this material by Luca della Robbia, the Florentine sculptor. At Florence one forgives the glitter and opacity of these works, the rounded obliteration of the last and finest thought and expression of the artist. Yet his terra-cottas, when not covered by the thick "majolica cream," if more injured, are marvellously finer.

Smears are closely allied to glazes, both in chemical composition and in decorative result, but their appearance, if less even, is rather more quiet and delicate. It is often noticed, that wares acquire a partial or slight gloss, through the volatilisation of alkalies or lead from other objects coated with glaze, and fired in the same kiln. And sometimes the same effect is produced when wares, during firing, throw up to their surfaces some of their more finely comminuted, or more fusible constituents. "Smearing" is now employed to a considerable extent, as affording a useful protection through the kind of half-glaze which it produces. Red lead, china-stone, salt, potash, bone-ash, nitre, litharge, and flint, admixed two or more of them together, or, in some cases, singly, are the chief constituents of smears, and are applied as a kind of wash on the inside of the saggers in which the pieces are fixed. "Flows" resemble smears; additional substances used in them are lime, alum, whiting, and sal-ammoniac.

Passing from glazes to colouring substances, we find that the preparations employed in ceramic decoration may be classified rather by their manner of application than by their chemical composition, although this has to be modified according to the material to be painted, and the temperature of the firing. Some colours are, in the body, encaustic; some are on the body and under the glaze; some are in the glaze, and some are over the glaze. This list by no means exhausts the series, for we have colours placed upon slip, and others on enamel. A very large variety of colour effects are producible by the position of the colouring substances, while nearly as much may be said of the results attainable by varying the quantity and nature of the associated constituents

of the ceramic pigments, whether these constituents be fusible or refractory.

Encaustic colours were used by Wedgwood, in his classical paintings upon basaltes and coloured clay bodies; they consist of slips of opaque clay, to which various colour oxides, such as those of cobalt, chronium, and iron, are added. They are employed in *pâte sur pâte* decoration, and very extensively in paving tiles and mosaic tesseræ. They are applicable to opaque bodies, and to those that are translucent; to those fired at low as well as at high temperatures.

Enamel colours illustrate another way of employing the colouring power of certain metallic oxides; in these there is a glass of silicate of cobalt, silicate of iron, &c., or of borate. China clay is mixed with some, and with some felspar; some are nearly pure silicates. Pure oxides, as that of cobalt, do not belong here, and such preparations are mainly used for underglaze painting, on such bodies as need a high temperature for firing.

Some interesting contact points between chemistry and art come out, on the consideration of the several metals to which the colours of pottery and porcelain are due.

Iron yields a fine red when fully oxidised, and then neither alkali, nor lime, nor barytes, nor magnesia, nor a very high temperature, impair its beauty. Much of the Kaga ware of Japan, and the underglaze red of certain Chinese porcelains, illustrate this point. Then the silicate and borate of protoxide of iron are green; the mixed oxides brown, or even black. But much depends upon the form in which the iron is introduced, much upon the temperature, and much upon the fuel. The effects of alkaline bases on iron hues have been pointed out in the previous lecture; an instructive example is furnished, as I pointed out many years ago, by the red chalk of Hunstanton, in Norfolk. When strongly ignited, this becomes an olive green, owing to the formation of the compound—Fe_2O_3, CaO.

Cobalt, from which the majority of our blues are derived, is difficult to manage, both in hue, depth, and brushwork or application. The bold pulsating blue of choice specimens of old Chinese blue and white is perfect, so is much of that found in Persian, Damascus, or Rhodian *faïence*. When the cobalt contains nickel, or manganese, or iron, very usual impurities, it is greatly injured; at least, its hue becomes so modified towards grey, indigo, or purple, as to lose its distinguishing beauty.

Copper, though of a rich green in the form of silicate, becomes, by reduction to suboxide, capable of yielding a characteristic red. Pleasing effects are produced by blowing a reducing mixture, in spray, upon the turquoise green enamel of certain cupreous preparations.

Manganese may yield a puce, a violet, or a plum colour. It probably does not exist in ceramic pigments, either as MnO_2, or salts of MnO. Its beauty is frequently dulled by ferruginous impurities, sometimes by baryta or copper. With chromium and cobalt it yields a black.

Chromium is known to exist in two conditions of oxidation; one bluish-green, the other yellow; when bases are abundant, it more readily tends towards the latter state. But chromium yields, in the presence of tin (of stannic oxide), a beautiful rose colour, which is generally known as "pink colour," and has been largely used in ceramic decoration. The peculiarity of the composition of this colour lies in the very small proportion of chromium which it contains.

Almost every metal belonging to what is called the "heavy" class, may be used for colouring—the alkaline metals, the earthy, and the alkaline-earthy, are destitute of this power.

After colours come lustres. They do not necessarily depend upon the actual metallic condition of certain constituents on the surface. Nor do metals, even if free, that is, in their proper metallic condition, invariably present a lustrous appearance. The metal employed for lustring is bismuth, patented by Brianchon, and imitated at Worcester and Belleek; it gives a beautiful iridescence, which has been too lavishly used—smeared over everything—or it would be more appreciated. Copper and silver give lustre to Italian wares, decorated at Gubbio, Pesaro, and Deruta, and also to some wares produced in Persia and in Spain. In the last half of the eighteenth century, at Brislington, near Bristol, and in Staffordshire, by Wedgwood, lustres fair in tone, but unsuccessful in decorative treatment and association with other colours, were made. Gold was used by Wedgwood, not only for ordinary gilding on his wares, but also for staining them and lustring their surface. Platinum was employed by several potters of the eighteenth century, in Staffordshire. Messrs. Lockett and Co., of Longton, in 1862, manufactured many lustred pieces. Carrocci, of Gubbio, now prepares a beautiful ruby lustre; and for some years past, Mr. William de Morgan, of Great Cheyne-row, Chelsea, has produced both ruby and mother-of-pearl lustres of great beauty. The designs on his pieces are so fresh and so good that one cannot but rejoice in this combination of remarkable excellence in drawing and chromatic effect. More recently, Mr. George Maw, of Benthall-hall, Broseley, has turned his attention to the production of lustres. His ruby lustre frequently (in fact, nearly always) possesses that quality of transparence which marked the Gubbio ruby, and which modern lustres nearly always miss.

In drawing your attention to the specimens on the table, some of which are old, and many new, some European and some of Eastern origin, it may be useful if I point out, not only the lessons which individual examples may teach, but a general difference of character or feeling between modern work, and much European work generally, on the one hand, and old and most Eastern work on the other. As such general difference lies almost wholly in the glaze and its associated chromatic elements, this place seems to be the most appropriate for its consideration. Modern work is prosaic, laboured, uninteresting. If it be learned, it is not learned enough. If its decoration were the outcome of nothing more than unspoilt tradition, the decorative result would be more satisfactory. But the obvious striving after effects and qualities which are yet imperfectly realised, pains the artistic sense of those persons who are familiar with the productions of other times and other countries. If one examines a modern piece of English turquoise glaze, a very noticeable defect obtrudes itself on the eye at once. The colour is staring enough,

strong enough (what the French call *voyant*) and speedy, but muddy withal; you cannot look into it. If a mottled, or flooded, or varied glaze be attempted, the result realises the mottling or other peculiarity of the Chinese original distinctly, but misses its easy, careless grace, whereby art conceals artifice. Of course all modern and all English work is not amenable to such criticism. For instance, Mr. W. De Morgan's Persian tiles are worthy of unqualified praise. On the red body beneath, a white slip or wash is placed, which, while illuminating the nearly transparent turquoise, puce, and blue glazes above, does not reveal itself, nor disclose the mechanism of the final success. Here, too, the design of the ornament, the quality of the lines, the degree of gloss, and the blending of contiguous colours are all just simply perfect. And it is not difficult to discover similar meritorious elements in the productions of other factories. Here is a specimen of modern Hungariau earthenware, in which, upon a softly mottled ground of deep-colour and crimson, a graceful network of golden foliage is spread. And these beautiful tile-pictures, by Messrs. Simpson, of St. Martin's-lane, illustrating both underglaze and overglaze painting, show the association of high artistic power with the frank recognition of the nature of the materials, and the uses to which the objects are to be put.

A few words must now be said about the specimens of glazes and colours, which are on the table. Ferruginous glazes are shown in these Japanese bottles, and in this tyg of the 15th century, from the ruins of the Blackfriars monastery in Bristol. This English mediæval jug shows a green glaze, due to a silicate of lead, copper, and iron. This large mottled Chinese dish, and this octagonal old Staffordshire tortoise-shell plate, owe their colours to manganese, copper, antimony, and iron, the glaze in both cases being rich in lead. A milk jug, of about 1750, shows how a lead glaze brings out the colours of the two clays, one white, the other buff, from which the vessel has been fashioned. This old Staffordshire agate-ware sauce boat exhibits the softening, because solvent, effect of a lead glaze upon the irregular patches and strings of parti-coloured clays, tinctured with cobalt and iron, of which it has been formed. A Japanese plate, by Kenzan, of about 1720, exhibits the effects of a vitreous glaze upon a rough clay, and also affords a good example of glaze upon a white slip. Another bit of Japanese ware, quite modern, is of buff clay on white; the simple decoration is in delicately pencilled white clay, the glaze just developing the colour of both body and design, and not obtruding itself by excessive gloss. Here is a bowl of old Kaga ware, where the brown body tones down the brilliancy of all the enamel colours, save the opaque blue, with which it is decorated. Here, again, is a tea bowl, where the one point noticeable is a rich brown glaze, free from lead, but of absolutely perfect gloss. Looking into this glaze, we see its tones are beautifully varied from base to lip, and that there is no monotony, as of textureless varnish, anywhere in its substance. A white, porous clay bowl, with cinque-foils in manganese, purple and dim undulatory lines of cobalt blue, both underglaze, shows the penetration of these colours into the body, and how the glaze has softened and united the whole into harmony. Often, in these Japanese wares, we may notice the play of colour and texture obtained by such simple means as glazing with a colourless glaze one part of a vessel, leaving another part unglazed, coating another part with a white enamel or slip, and tincturing a fourth part with some ceramic colour. This treatment has been adopted with this vessel, shaped as a leaf, and lends itself with peculiar appropriatenes to the conventional representation of the texture, substance, and colour of veins, undulations, and margins. Of other glazes on Japanese wares, here are half a dozen characteristic examples, each capable of teaching a useful lesson to Western potters.

These examples of Persian and Rhodian wares and their imitations are most instructive; they show, above all things, how useless it is to attempt the imitation of an effect by means of processes and materials having wholly different physical and chemical characters. Does this modern attempt at Persian *faïence* realise any of the beauties of the original? Is it not a ridiculous caricature? Look at the carefully painted imitation of the flooding or spreading at the edges of the colours. Look at the opaque, uninteresting body. Here is no going downwards into the clay, and no dissolving upwards in the glaze.

The stanniferous enamels of Italy are seen at their best in such examples as this drugwase of Caffagiuolo; at their worst in this plate of Italian origin of about 1710. Bristol, Liverpool, and Dutch tiles of the eighteenth century may also teach us useful lessons, especially when we compare them with these works of Deck and Pinart (both of Paris), in which the stanniferous enamel and the enamel painting which it carries are fired at the same time.

MISCELLANEOUS.

REPORT ON TWO EXPEDITIONS TO MIDIAN.

By Captain R. F. Burton.

The following lines contain a concise account of the circumstances which, during the last three years, have connected me with the Egyptian province, El-Madyan.

H. H. Ismail I., honoured me, through Mr. Frederick Smart, with an invitation to visit Egypt, and to lay before him certain details which I had collected concerning mineral wealth in N. Western Arabia.

I left Trieste on March 3rd, 1877. A small expedition was at once prepared: it set out for El-Muwaylah on April 2nd; and returned to Suez on April 20th. During those 18 days we found, by examining four sites, that the country had been extensively mined, while a larger area remained untouched. I brought home specimens of gold, silver, galena, zinc, copper, sulphur, iron, and other metals. H.H. was much pleased, and promised me, in presence of Mr. Smart and of other persons, either a concession or a royalty of 5 per cent. on gross produce.

Returning from the first expedition I had the honour to recommend:—1. Mr. Charles Clarke (of Zagazig) for the rank of Bey. 2. Lt. Hasan Effendi Haris and Lt. Amir Effendi Rushdi for a step in promotion. I also solicited a small life-pension for Haji Wali (El-Din)

of Zagazig, who had drawn my attention to the mines of El-Madyan.

On October 9th, 1877, I again left Trieste. After some delay at Cairo, the second expedition set out from Suez on December 11th; and returned on April 12th, 1879. During this journey of four months, Mr. Marie, the engineer sent out by H.H., collected some 20 tons of specimens; and I was directed to have them assayed in London, while Mr. Smart was charged, in my presence, with furnishing the necessary funds. The analysis was duly made and the printed report was forwarded to Egypt; but funds were not forthcoming, and the consequence was, that I was compelled to supply them.

Returning to Cairo I renewed my request touching the pension of Haji Wali; I again submitted for promotion the names of Mr. Clarke and Lt. Amir Effendi Rushdi; and I added to them that of Ahmed Kaptàn Musallam. Moreover, for the better government of the province (El-Madyan), which is about to assume new relations with Egypt, I had the honour to propose—1. That Sayyid Abd el Rahím, accountant of the Fort El-Muwaylah, be raised to the rank of Nàzir, or commandant. 2. That Mohammed Shahadeh, Ex-Wakil of El-Wijh be made commandant of that fort. 3. That some token of H.H.'s favour be conferred upon Sheykh Alayàn Bin Rabi of the Huwatàt tribe, Sheykh Furayj of the Huwatàt tribe, Sheykh Hasan ibn Sàlim El-Ukbi.

For the safety of Egypt and Europe I also recommended that the quarantine establishment be re-transferred from Tor harbour to El-Wijh.

Since leaving Cairo (May, 1878), I have repeatedly written concerning the administrative measures to be adopted before the country can be regularly exploited, but hitherto my representations have remained unnoticed.

I now return to the mines. The result of the assays made by three several establishments is so far encouraging that Dr. Percy, one of the highest authorities on metallurgy, declares "These indications of the presence of the precious metals certainly justify further explorations." Such exploration I am prepared to undertake.

I left Trieste on December 5th, 1879, and came to Cairo ready for a third expedition. This time the conditions of exploitation are more favourable, as I have no longer to seek for the sites which are best fitted for beginning operations.

It is, however, evident that no syndicate, no company, would risk capital upon a project, however promising, without the prospect of enjoying the fruits of success. Certain capitalists in London are willing to aid me, but it will be upon conditions that a formal contract or concession be granted to me.

The *Nouveau Règlement sur les mines de l' Empire Ottoman*, inserted in the Tranzimat (Constitution) and bearing date July 17th, 1861, authorises this concession, and lays down all the legal conditions regarding royalty and other matters.

An objection might be raised that the *Règlement* applies to subjects of the Porte. But, firstly, there are precedents for extending the privilege to foreigners; for instance, in the case of the minerals about Sidon. Secondly, this proviso, made for Turkey proper, is not applicable to Egypt, where there are now international tribunals. Disputed questions of royalty, jurisdiction, &c., could be settled by arbitrators, the latter nominated in equal numbers by the Government and the company.

The public will observe that I am not acting as one who seeks to receive favours from Egypt. On the contrary, I propose to develop a province which has been for centuries, and which still is, a howling wilderness, occupied by a few hundred Bedawìn. I propose to benefit Suez and the adjacent parts of Egypt by creating an industry and a traffic where there is now nothing of the kind. Lastly, I propose adding to the resources of H.H.'s Government, by making over to it the legal share of whatsoever profits may accrue from the exploitation of El-Madyan.

Under these circumstances I have a claim to expect the realisation of a project whose views are of the most legitimate. And the first steps would be—1st. A contract or concession drawn up in due form. 2nd. An authority to carry out the measures proposed for the government of the province; especially the rewards due to the military officers and the civilians who assisted in exploring El-Madyan.

THE NATIVE SILKS OF ASSAM.

By C. G. Warnford Lock.

The native silks of Assam, known as *Eria* and *Muga*, are the produce respectively of *Attacus Ricini*, and *Antheræa assama*, and *Antheræa Mezankooria.*

The *Eria* worm is so called from the local name of the castor-oil plant (*Ricinus communis*), on which it is almost exclusively fed. It is reared entirely indoors. The duration of its life varies with the season: in the summer, it is shorter, and the product is both better and more abundant. At this season, 20 to 24 days elapse from the date of its birth to the time when it begins its cocoon, 15 days later the moth is produced, in three days the eggs are laid, and in five more they are hatched, making the total duration of a breed 43 days. In winter, its life extends to nearly two months. Seven breeds are reckoned upon annually. For breeding, the natives select cocoons from among those which begin to be formed in the largest number on the same day. Those containing males are recognised by a more pointed end. On the second or third day after the cocoons have begun to be formed, they are put into a closed basket, and hung up in the house, out of reach of vermin and insects. Twenty-four hours after the moths have been produced, the females are tied to long reeds or canes, 20 to 25 to each, and these are suspended in the house. The eggs laid during the first three days alone are kept; they are tied up in a piece of cloth, and hung from the roof till a few begin to hatch; these eggs are white, and resemble turnip seed in size. When a few of the worms are hatched, the cloths are put on small bamboo platters, and here they are fed with tender leaves. After the second moulting, the worms are removed to feed on bunches of leaves, suspended a little above the ground, and a mat is spread beneath to catch those which fall. When they have ceased feeding, they are placed in baskets filled with dry leaves, amongst which they form their cocoons. In four days, the latter are complete. A selection having been made for the next breed, the remainder are exposed to the sun for two to three days, to destroy the vitality of the chrysalis. The cocoons are next generally put into water containing potash (wood-ashes), over a slow fire; when removed, the water is gently squeezed out. At other times, they are massed together for some days with *amrita* (? *Carica papaya*) or *madhu* fruit. The object is the same in either case, viz., to facilitate the drawing of the silk. The cocoons thus treated are taken one by one, and the silk is placed within the thumb of the left hand, whilst the right is employed in drawing out the silk. Any inequalities that may exist are reduced by rubbing them down between the thumb and finger; the same process serves for joining on new cocoons. The thread is allowed to accumulate in quantities of about half-a-pound; these are afterwards exposed to the sun, or placed near a fire, till dry, when they are wound up into skeins. The silk is then ready for the weaver. It is the coarser of the two kinds, and none of it ever finds its way into Bengal.

The *Muga* moth is found wild in the jungle, but all the silk produced by it is from domesticated worms. They are reared on trees in the open air. There are

generally five broods in a year, viz., January to February, May to June, July to August, September to October, and November. The first and last yield the best crops, as regards both quantity and quality. Constant watching of the tree is necessary. By day, crows and other birds pounce upon the worms, and devour them. By night, bats, owls, and rats are very destructive. Numbers of the caterpillars are destroyed in the more advanced stages by the sting of wasps, and by the ichneumon insect, which deposits its eggs in the bodies of the worms. The latter thrive best in dry weather, but a very hot sunny day at the moulting time proves fatal to many. Indeed, at this period, rain is considered very favourable; and even thunderstorms are not injurious, as they are to the mulberry worm. Continual heavy rains do mischief by sweeping the worms off the trees; but showers, however violent, cause no great damage, the worms generally taking shelter under the leaves with perfect safety. During moulting, the worms remain on the branches, but when about beginning to spin, they come down the trunk. Bunches of fresh plantain leaves are tied round the trunks at some height from the ground, in order to arrest their progress. The worms are then collected in baskets, which are put under bunches of dry leaves, suspended from the roof of the house; they crawl up into these, and there form their cocoons. The total duration of a breed varies from [illegible] to 70 days; the period is thus divided:—4 moultings, 20 days; from fourth moulting to beginning of cocoon, 10 days; in the cocoon, 20 days; as a moth, [illegible] days; hatching of the eggs, 10 days; total, 66 days. The chrysalis not being easily killed by exposure to the sun, a number of cocoons are placed upon bamboo stages, and covered with leaves, while a quantity of dry grass is ignited below them, and in a short time destroys them. The cocoons are then boiled for about an hour in water containing potash (the ashes of mustard and other plants). When taken out, they are laid between folds of cloth. The floss is removed by hand, and the cocoons are thrown into hot water. The instrument used for winding off the silk is the roughest imaginable. A thick bamboo, about 3 ft. long, is split in two, and the pieces are driven equally into the ground about 2 ft. apart; over the interior projection of one of the knots is laid a stick, to which is fixed, a little on one side, a round piece of plank, about 1 ft. in diameter. The rotary motion is given by jerking this axle, on which the thread rolls itself. In front of the vessel holding the cocoons, a stick is placed horizontally for the thread to travel upon. Two persons are employed—one attends to the cocoons; the other jerks the axle with the right hand, and with the same hand draws the thread up the left forearm, so that it is twisted in coming down again towards the hand, while the left hand conducts the thread over the axle. The Assamese consider it a good annual return if an acre of trees support 50,000 cocoons, yielding upwards of 24 lb. of silk. It must be very profitable, as 1,000 cocoons are reckoned to afford 6 to 8½ oz. of silk thread, selling at 10s. to 12s. a pound. The labour and expense of maintaining a plantation of the trees is very trifling.

Two kinds of silk are distinguished by the natives as the production of the Muga worm—*muga* and *mujankuri*, their difference being attributed to the trees on which the worms are fed; but naturalists have determined a specific difference in the worms themselves, calling the former *Antheræa assama*, and the latter *Antheræa Mezankooria*. The *Muga* worms feed chiefly on the *Sum* tree (? [illegible]; *Tetranthera lanceolata*): *mujankuri*, from those fed on the *Adakur* tree (? *Tetranthera* [illegible]). The latter is whiter and better than the former. Some of the silk thread produced in Sibsagar sells for as much as 36s. a pound. Lakhimpur, in 1871, exported [illegible] tons of *Muga* silk thread, valued at £6,090.

The reader may refer to the *Journal*, May 9th, 1879, for further information on Indian wild silks.

CULTIVATION OF THE FIG IN TURKEY.

The United States Consul at Smyrna states that the Aidin district is the only one which produces figs for exportation. The fruit will grow anywhere in the neighbourhood of Smyrna, of a good quality for consumption, in a green state; but the Aidin plain is unique in its climate and soil as being favourable for the proper curing of the fig. The thermometer seldom falls below three or four degrees under freezing point, and in the summer seldom rises above 130 degrees Fahrenheit in the sun. In Aidin, the winters are generally wet, the dry weather commencing in May and continuing till the end of October. Any rain at the end of July, or during the month of August and September, when the fruit is under the process of drying, injures the quality, by causing it to burst, hardens the skin, gives the fig a dark colour, and spoils its keeping quality. Heavy dews will cause the same evils.

The fig tree will grow in almost any soil; a rich heavy soil is, however, preferable; but to produce figs that will dry well and please the merchant, the soil ought to be of a good depth, and of a rich, light, sandy nature; this, if the weather be favourable, will produce large figs, of a white thin skin, and of the finest quality. Before planting, the ground is well ploughed two or three times to a good depth, well fertilised, and freed from all weeds and extraneous roots. The fig is propagated from slips, selected with as many fruity buds as possible. To form a tree, two slips are planted, one foot apart, and then joined at the top. The trees, if planted in rich soil, should be placed about 30 feet apart, and for poor soil about 25 feet distant from each other. The cuttings are planted in the month of March, two in each hole, at about 9 inches or a foot apart at the root end, and during the growth of the trees, the ground is ploughed up two or three times during the winter or spring, and the space between them is used to cultivate cotton, sesame, or Indian corn.

The fig harvest generally lasts about six weeks, and when the fig is ripe, it falls of its own accord from the tree. Women and children are employed to pick up the fruit into small baskets, to be conveyed to a place in the garden well exposed to the sun, where they are spread on a bed of dry grass, or matting, singly, and not one on the top of the other, and are turned over every day, in order to get every part of the fig exposed to the sun. After a few days of this exposure, those figs which are sufficiently dry are selected from the mass, and divided into first, second, and third qualities, care being taken not to dry them too much. They are then sent to Smyrna, where they are assorted and packed for shipment.

On arrival at Smyrna, they are conveyed to the fig bazaar, or market place, where the merchants attend early next morning to effect purchases. The parcels belonging to each individual owner are separately examined, each purchaser giving his own price; a broker is nearly always employed as an intermediary by the merchant, on payment to him of 2 per cent. of the value, the amount being ultimately refunded by the seller. A seller is but seldom the owner himself, this latter being generally represented by a Jew or Armenian merchant, at an exorbitant charge of 7 per cent. as a commission. The figs are then, after purchase, conveyed to the packing establishment, to undergo manipulation and putting into boxes; the sacks are emptied out on the floor in a square heap, and on all sides are squatted rows of women and girls, employed in merely twisting round each fig two or three times between the forefinger and thumb, to render it soft, and give it the required oblong form. On the heap are a row of low baskets, into which are thrown separately the first and second qualities to be used for packing; at least 10 per cent. of the whole mass is worthless for putting up in cases, and, during the first process, the inferior fruit is picked up and thrown in a separate heap. Undersized, tough,

or spotted figs, and such as are burst, come under this category, and are packed, or rather preserved, promiscuously in small boxes, and labelled "Figs for family use." Sometimes, when the parcel is unusually good, three qualities are selected instead of two. The figs are then laid on long benches, at which are seated the practiced packers. Each man has a box before him, and swiftly and dexterously the figs are placed alongside each other in rows, the rows varying in number according to the depth of the box, the flat ones, which are in more general use, requiring but two. This mode of packing is called "pulled." Above all, a row of "layers" is then placed, to show the figs to advantage. The "layers" are stretched out by means of both hands, and laid flat side by side in parallel rows. Of late years, "layers" throughout the boxes have come into great demand, and nearly all the best qualities are packed in this way. In packing, the fingers are now and then dipped into a bucket of sea-water, to ease their working; the figs become thus moistened with salt water, which it is said, has the effect of hastening their sugaring. The boxes are again passed on to the women, who complete the process by placing laurel leaves between the upper rows, before the final nailing down and polishing off by the carpenter. The packages used are of various dimensions and forms; at one time all figs exported to the United States were placed in drums or paper boxes, but of late years flat wooden boxes are being extensively shipped. Very few drums, if any, find their way to the English market, to which the best qualities are usually sent. America consumes but little of the superior qualities, though the demand for such has now increased. Small canvas bags are now being used with much success, and in fact, every season some novelty in the style of packing may be noticed. The refuse, or "naturals," are put into large boxes or barrels, and shipped to England, Egypt, Europe, and Turkey, the high rate of duty in America entirely excluding those inferior figs from the market.

TONG-PANG-CHONG.—A CHINESE REMEDY FOR CUTANEOUS DISEASES.

The pharmaceutical products of China and Japan offer an interesting field for experiment into their compositions and probable values. From time to time, new drugs from various parts of the world are brought to European notice, and of late years many have been found to be of great practical usefulness, and are now included amongst our important medicines. Though the number and variety of the substances used in medicine by the Chinese and Japanese are very great, and though very complete collections of the drugs of these countries have been exhibited at the various exhibitions, notably at the last Paris Exhibition, little has been effected towards introducing them in quantity for trial by medical men in this country. Something, indeed, was done a short time since in this direction by Mr. Thomas Christy, who introduced a number of raw vegetable products used as drugs in Japan; these were identified and described in a series of notes published in the *Pharmaceutical Journal* at the time. Mr. Christy has quite recently received a consignment of a drug which is reputed to be very valuable in China, for the cure of certain skin diseases; it is known under the name of Tong-pang-chong, and is said to be produced by a plant growing in Siam, whence it finds its way to China. In the Kew report for 1877, where the substance is referred to, it is stated that the chemists in Hong Kong say that they can procure an almost unlimited supply, and even hint at getting and growing the plant there. From information gathered from China, before the report was written, and from comparison of a very small sample sent to this country with some roots, which appeared to be identical, contained in the Kew Museum, there seems but little doubt that this interesting and peculiar remedy was produced by an Acanthaceous plant, known to botanists as *Rhinacanthus communis.* Whether the material now in Mr. Christy's hands will prove the accuracy of this preliminary determination remains to be seen, as also the question of the actual efficacy of the drug itself.

WINES OF CHILI.

The vine was introduced into Chili by the Spaniards, soon after their conquest of the country, but although its culture quickly extended over the central and southern provinces, it is only within the last twenty years that viticulture has been systematically carried on. The following particulars by Mr. E. Seve, of Valparaiso, are taken from the *Journal of Applied Science*:—

A large portion of the finest sets or cuttings of Europe, and chiefly those of Burgundy and Bordeaux, were imported. The production of wine consequently increased, and its use at table became general. The introduction of these French vines led to the Chilians abandoning much of their former culture and mode of wine-making, and adopting those of the country from which the vines were imported. The result of these efforts are now apparent. At present, in many of the provinces, especially of the centre, sound wholesome wines of an excellent quality, in a certain degree compete with similar products of the old world. Wine-making in Chili is at present a considerable and very profitable industry, and forms a principal source of the riches of the country. By the great diversity of its climate, the nature and topographical configuration of its soil, Chili offers the best natural situations for nearly all the classes of renowned wines.

The region suited for the vine in Chili extends from the north down to Biobio in the south. But in the south, the humidity of the climate will not allow the grapes to ripen without artificial means.

The vines are distinguished in the country either as Chilian or French. The vines in the country consist of the cock grape (*uva de gallo*), the white and black muscat, the black San Francisco, and the common black. The Chilian vines are met with chiefly in the South and the North. The French vines have been introduced almost entirely in the central regions, where they constitute extensive vineyards. The principal French varieties introduced and grown on a large scale are the Pinots, Gamais, Sauvignons, Cabernet, Malbeck, Cot-Rouge, Meunier, White Semillon, Folleblanche, &c. The Chasselas of Fontainebleau are met with on all the trellises of the gardens, the orchards, &c. In the greater part of the French vineyards in Chilli we find all these varieties very often mixed, conditions most unfavourable for wine-making, as the grapes do not ripen at the same time.

The choice of vines, and their suitability to soil and climate, so as to make a certain class of wine, is a question badly understood in Chili, and to which the attention of the vine growers should be directed, as upon the solution of this point depends in a great degree the future of the Chilian wine production.

The Chilian irrigated vines receive neither care nor culture during their growth; indeed they are hardly ever pruned after bearing.

The French vines, having more attention paid to them in culture, the soil is kept porous and in good condition, and the roots are cared for during the progress of vegetation. Thus, in the same climate, under the same conditions of soil, in the same vineyard, the French vines will ripen their fruit fifteen days to three weeks before those of the vines of the country, and give a much more abundant produce. The indigenous vines, treated after the French method, improve greatly. This fact is a striking example of the influence of culture on agricultural plants.

Up to the present time no serious malady has attacked the vines in Chili. The oidium has been long known there, but the climatic conditions are unfavourable to the propagation of this parasite. After some days of rain in the close of November a little damage has been done. In the Argentine Republic, about Mendoza, where the vine is largely grown, there have been serious complaints for some years of damage done to the vines. But it may be remarked that on the sides of the Cordilleras facing Santiago the rains occur in summer, while in the central regions of Chili they occur in winter. The phylloxera, fortunately, is not known in Chili, and the Government have forbidden the introduction of French cuttings, with the view of preventing the devastation.

The duration of the vine in Chili is considerable; vineyards of fifty years old are by no means rare. The principal kinds of wine made in Chili are as follows:—Those known as Burgundy and Bordeaux in the country are the produce of French vines, and the manufacture is carried on on the same principle. White wine is but little drunk in Chili, hence nearly all the wine made from the French grapes is red. The quality of the white wine is, however, superior to that of the red.

French vines, under good conditions, well cultivated, will yield 100 to 120 hectolitres of wine to the hectare; it is sold in the first year at 40 to 50 centimes the litre, which constitutes a considerable profit. The wine made from the French vines in Chili is consumed in the country and exported to the Pacific coasts.

Chacoli is a light wine made with the grapes of the country, and which is only slightly fermented in the vat. It is either white or red. This wine is principally drunk by the working classes.

The ordinary wine of Chili is a species of liqueur wine, resembling Malaga. It is made by adding to the ordinary "must" one-fourth or one-fifth part of boiled wine.

Mosto is made more or less like Burgundy and Bordeaux wines, and the manufacture is confined chiefly to the South. The province of Concepcion enjoys a high reputation for it.

Vino asoleado is made from grapes dried in the sun for fifteen or twenty days. The native processes of wine making are of the most primitive kind. The general introduction of good instruments and improved apparatus would render great service to Chili.

Chicha is a very common beverage among the poor. It is made much in the manner of white wine, except that the juice which issues from the wine-press is boiled.

In the province of Aconcagua, a good deal of spirit is distilled from wine. It is, however, of bad quality, owing to the faulty method employed. To cover the bad taste of the alcohol obtained by the direct distillation of the marc, it is the practice to add fennel seed. The spirit thus obtained is known as *anisado*.

LEATHER TRADE.

Particular attention is directed to the present condition of the hide and leather trades in an article in the *Market*, where the increased competition which the English tanner encounters, is pointed out.

"Taking first hides used in the manufacture of heavy leather, what strikes us is the activity amongst French and German houses for direct shipments. Formerly, England was the great centre for such goods, but now the Continent absorbs by far the largest portion of the trade, especially of South American produce. It is true that a proportion of these hides eventually find their way back to this country, and the strange part is that they are ever allowed to be landed elsewhere, at least to so large an extent. The fact is, after the Franco-German war, a new set of Anglo-German merchants came into existence, with correspondents all over the Continent, and in this way the importing houses are ruled by their foreign coadjutors.

"The rapid increase in the importation of foreign leather into this country during the past ten years supplies material for considerations deeply interesting in a public sense, and of vital importance to the British tanner. As our colonies and dependencies grow, flourish, and feel their strength, so they pour in upon us every product suited to their particular climates in overwhelming profusion. Our tanners now behold fac-similes of their manufactures sent from every quarter of the globe, yet cannot themselves export without encountering serious, ruinous, hostile tariffs."

From a table of the imports and exports of eleven years, from 1870 to 1880 (first ten months), it appears that, in 1870, the imports of leather amounted to 11,556,345 lbs., value £759,342, and the exports of unwrought leather amounted to 103,788 cwts., value £850,495; of wrought boots and shoes, to 372,601 dozen pairs, value £1,148,423; while, in 1879, the imports had risen to 35,175,036 lbs., value £2,204,386, the exports in the same year only stood at 219,829 lbs.; of unwrought leather, value £1,505,312; and 432,312 dozen pairs of boots and shoes, value £1,319,598. Thus the imports of leather more than doubled between 1870 and 1872, quadrupled in 1875, and almost quintupled in 1878, and seem likely to stand at the end of the present year 400 per cent. higher than at the commencement of the present decade. The exports of leather have materially increased, but not in proportion to the imports; while the foreign trade in boots and shoes, though above 1870, nevertheless seems stationary, and would be considerably less but for the "British possessions in South Africa."

SPONGE TRADE IN THE BAHAMAS.

The Report of the Governor of the Bahamas to the Secretary of State for the Colonies has been published as a Blue-book, with the Report of Professor Ray Lankester, on the artificial propagation of sponges appended. Governor Robinson states that "various causes combined to make the past year a most favourable one to those engaged in the sponge trade. A larger number of buyers than usual appeared in the market, and there was no period when it could be said that prices had a downward tendency. The very high prices offered at the beginning of the year were fully sustained to its end. This strong competition served to stimulate those actually employed in the fisheries to greater exertion, and induced a great many others to enter the business. Absence of heavy gales, and the mild weather that generally prevailed, contributed in a great measure to favour the efforts of fishermen to meet this increased demand. The successful results of last year's fishery are also somewhat owing to the rest the sponge beds had whilst the privilege of fishing on the coast of Cuba was accorded to the Bahamian spongers. Licenses to fish on this coast were again issued in 1879 to several vessels, but shortly after their arrival at the sponging grounds they were boarded by Spanish gun-boats and ordered to leave; some of them returned to port with insufficient sponge to pay the cost of their outfits."

Professor Lankester's report was made in accordance with the request of the Secretary of State for the Colonies, and contains the result of inquiries respecting the experiments initiated by Professor Oscar Schmidt, on the artificial cultivation of sponges for commercial purposes.

Mr. Lankester writes:—"The experiments in the Adriatic were carried out under the auspices of the Government during the years 1863-72, and were finally abandoned in November, 1872, on account of the difficulties which were encountered. It appears that the method of cutting a sponge into small pieces, affixing

these pieces to movable supports, and sinking the supports in the water where the sponges naturally occur, was found to be perfectly successful. The 'cuttings' of sponge attached themselves to the support, and proceeded to grow each into a well-shaped sponge like that from which the cutting was taken. Details are given in Dr. Von Marenzeller's report as to the best mode of taking the cuttings, and as to the best material for supports, also as to the time of year in which to operate, and other important conditions. It appears that from a small cutting (26 cubic millimètres in bulk) a sponge of marketable size would be produced in about seven years' growth. Whilst the experiments of the Austrian Government demonstrated the soundness of Professor Oscar Schmidt's suggestion, in consequence of which the cultivation was attempted, yet two difficulties sufficed to put a stop to the undertaking. Firstly, the native population, more especially the fishermen, had a great objection to these experiments, fearing that they might lead to the injury of the sponge trade, and consequently they persistently disturbed and robbed the experimental sponge bed. It was necessary that the sponge cuttings on their supports should be placed in an open unprotected bay, in order to secure the requisite condition of the sea water, and natural food of the sponge, and at the same time the expense of protecting the bay during a long series of years against the depredations of the fishermen would have been very great, and incommensurate with the profit to be obtained by the sale of the sponges when full grown. The hostility of the population of the Adriatic coast was then the chief cause of the abandonment of the experiments. But, further, the slow growth of the sponges (first established as a fact by these experiments), and the expense of obtaining the cuttings, and of making and sinking the supports, seemed to show with considerable clearness that the profit to be obtained by such a system of cultivation would be extremely small.

"It may be possible, by means of the system of sponge cutting, proposed by Professor Oscar Schmidt, to introduce sponges into new situations previously unoccupied; and experiments in this direction, though requiring great skill and knowledge of the conditions favourable to sponge growth, would be worth trying. Excepting with this object, the method of sponge cutting does not seem to be one of any promise.

"In relation merely to the management of an existing sponge fishery, I am of opinion that all that can be done by official control is to prevent the contamination or unnatural disturbance of the waters and bottom where the sponges grow; and, secondly, to strictly enforce a limitation of size in regard to those sponges which are fished and sold. Only large sponge should be moved from the sea bottom for the market, and all smaller and incompletely grown specimens should be returned to the waters by the fishermen immediately when taken. Further, the ground on which the sponges grow should not be too often dredged, but only at certain intervals in the year. In making these recommendations, I am supported by the opinion of Professor Schulze, who has, during the last six years, devoted himself to the study of the life history of the Adriatic sponges, and has added many most important facts to our knowledge of these animals."

OBITUARY.

John Joseph Mechi.—This well-known agriculturalist, whose death occurred on Sunday, 26th inst., was for many years a member of the Society of Arts, and served both on the Council and on various committees. He was born in London in May, 1802, and was the son of Signor Giacomo Mechi, a native of Bologna. He commenced business early in life at a small shop in Leadenhall-street, and shortly afterwards invented his "magic razor strop." In 1840, he purchased the farm of Tiptree-hall, consisting of one hundred and seventy acres of inferior land, and at once proceeded to apply scientific principles to agricultural practice. He read the first of a series of papers on his farming operations before the Society on November 27th, 1850, and on March 7, 1860, a paper on "The Application of Town Sewage to a large Agricultural Area." He also joined in many discussions at the meetings, and contributed letters to the *Journal*. The last occasion upon which he spoke, was after the reading of Mr. J. C. Morton's paper on "Agricultural Experience," on May 5th of the present year. Mr. Mechi was a juror of the Great Exhibition of 1851, and of the Paris Exhibition of 1855. He was appointed Sheriff of London in 1856, and Alderman of Lime-street Ward, in 1858. On the failure of the Unity Bank, in 1866, of which he was Governor, he resigned his Aldermanic gown, much to the regret of his constituents and of his colleagues. Having determined to pay his share of the liabilities of the bank, which greatly crippled his resources, he felt he should be unable to bear the expenses of the mayoralty. Although Mr. Mechi had attained a good old age, there appears to be no doubt that his death was immediately caused by the misfortunes that overtook him at the end of his useful career. This naturally adds to the regret of the large numbers who now deplore his loss.

GENERAL NOTES.

Ink for Etching on Glass.—An ink which can be employed for writing upon glass, has lately been brought out by Messrs. Sabatier and Co. It consists mainly of hydro-fluoric acid; but there are some other ingredients mixed with it, which enable it to be used as an ink, and which prevent the dangerous fumes which are found so inconvenient in using the simple acid.

Electric Light.—Mr. J. E. H. Gordon, according to *Nature*, has lately patented a method of producing light from electricity, based upon Mr. Spottiswoode's suggestion, to apply the alternating-current magneto-electric machine of De Méritens to the induction-coil. Mr. Gordon arranges small balls of platinum or iridium, or of an alloy of these metals, at the ends of fine platinum rods in pairs in the middle of a suitable globe, and causes to pass between them a rapid succession of sparks, whereby they are raised to incandescence. There is no consumption of carbon or any other substance, and the lamps may be connected either in series or in parallel branched arcs. The principal remaining disadvantage is the noise attendant on the rapid sparks. A mechanical contrivance is added to bring the knobs near together when no current is passing in the primary coil. The induction-coils used are of comparatively small size.

Turin Industrial Museum.—The Royal Italian Industrial Museum was founded at Turin, after the close of the International Exhibition, held in London, in 1862, and the collection for the purpose, made by the Royal Commissioner for Italy, were transferred to a large building, originally a convent, then a provincial college, and the office of the Minister of War, before the seat of Government was transferred to Rome. One of the departments of the museum is the *Archivio Industriale*, in which are preserved and classified the priced lists, illustrated catalogues, and technological pamphlets lately received from all parts of the world. The information contained in these catalogues is freely at the service of all who apply for it, and the authorities are desirous of receiving such lists from all who are willing to send them. The conservator of the museum, Chevalier Jervis, was deputed to collect further objects at the Paris Universal Exhibition in 1878, when he received a large number of objects as gifts from exhibitors in the British Section, and from those connected with the British colonies.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

January 12.—"A Sanitary Protection Association for London." By W. Fleeming Jenkin, F.R.S. On this evening Professor Huxley, LL.D., F.R.S., will preside.

January 19.—"Causes of Success and Failure in Modern Gold Mining." By A. G. Lock.

January 26.—"Five Years' Experience of the Working of the Trade Marks' Registration Act." By Edmund Johnson.

February 2.—"Trade Prospects." By Stephen Bourne.

February 9.—"The Present Condition of the Art of Wood-carving in England." By J. Hungerford Pollen.

February 16.—"The Participation of Labour in the Profits of Enterprise." By Sedley Taylor, M.A., late Fellow of Trinity College, Cambridge.

February 23.—"Recent Advances in Electric Lighting." By W. H. Preece, Pres. Soc. Tel. Eng.

March 2.—"Flashing Signals for Lighthouses." By Sir William Thomson, LL.D., F.R.S.

March 9.—"Improvements in the Treatment of Esparto for the Manufacture of Paper." By William Arnot, F.C.S.

March 16.—"The Manufacture of Aërated Waters." By T. P. Bruce Warren.

Dates not yet fixed:—

"Buying and Selling: its Nature and its Tools." By Prof. Bonamy Price. On this evening Lord Alfred S. Churchill will preside.

"The Discrimination and Artistic Use of Precious Stones." By Prof. A. H. Church, F.C.S.

"The Compound Air Engine." By Col. F. Beaumont, R.E.

"The Increasing Danger to Life and Property from Explosions." By Cornelius Walford.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

February 1.—"The Industrial Products of South Africa." By the Right Honourable Sir Henry Bartle Frere, Bart., G.C.B., G.C.S.I., D.C.L., LL.D., F.R.G.S., &c.

February 22.—"The Languages of South Africa." By Robert N. Cust.

March 15.—"The Loo Choo Islands." By Consul John A. Gubbins.

April 5.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

January 27.—"A New Mechanical Furnace, and a Continuous System of Manufacturing Sulphate of Soda." By James Mactear.

February 24.—"Deep Sea Investigation, and the Apparatus used in it." By J. G. Buchanan, F.R.S.E., F.C.S.

March 24.—"The Future Development of Electrical Appliances." By Prof. John Perry.

Indian Section.

Friday evenings, at eight o'clock:—

January 21.—"Forest Conservancy in India." By Sir Richard Temple, Bart., G.C.S.I.

February 11.—"The Gold Fields of India." By Hyde Clarke.

March 4.—"The Results of British Rule in India." By J. M. Maclean.

March 25.—"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Second Course will be on "Watchmaking," by Edward Rigg, M.A. Three Lectures.

February 7, 14, 21.

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

March 7, 14, 21, 28.

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Three Lectures.

April 25; May 2, 9.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

May 16, 23, 30.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 3rd...British Architects, 9, Conduit-street, W., 8 p.m.
Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. F. N. Newcome, "The Simultaneous Construction of Compound Interest and Annuity Tables."
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Dr. Andrew Wilson, "The Past and the Present of the Cuttle Fishes."
London Institution, Finsbury-circus, E.C., 5 p.m.

Tuesday, Jan. 4th...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. Dewar, "Atoms." (Lecture IV.)
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m. Annual Meeting.
Biblical Archæology, 9, Conduit-street, W., 8½ p.m. Annual Meeting.
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Dr. Albert Günther, "Account of the Zoological Collection made during the Survey of H.M.S. *Alert* in the Straits of Magellan, and on the Coast of Patagonia." 2. Prof. Flower, "The Sea Elephant."

Wednesday, Jan. 5th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 7 p.m. (Juvenile Lecture.) Mr. G. J. Romanes, "Animal Intelligence." (Lecture II.)
Geological, Burlington-house, W., 8 p.m. 1. Mr. C. Callaway, "The Archæan Geology of Anglesey," with a Note on "The Microscopic Structure of some Anglesey Rocks," by Prof. T. G. Bonney. 2. Mr. C. Callaway, "The Limestone of Durness and Assynt." 3. Prof. T. G. Bonney, "A Boulder of Hornblende-Pikrite, near Pen-y-Carnisiog, Anglesey."
Archæological Association, 32, Sackville-street, W., 8 p.m. Dr. Wake Smart, "Notes on Roman Remains, from Nursling, Hants." 2. Mr. G. R. Wright, "The Hardships of the Present Law of Treasure Trove."

Thursday, Jan. 6th...Royal, Burlington-house, W., 4½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Henry Morley, "Our Living Dramatists."
South London Photographic (at the House of the Society of Arts), 8 p.m. Popular Lantern Display.
Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. Dewar, "Atoms." (Lecture V.)
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. R. Harkness Twigg, "Accounts of Sombrero Islands, West Indies, with a Discription of Sub-marine Quarrying of Phosphate of Lime."

Friday, Jan. 7th...Teachers' Association (at the House of the Society of Arts), 10½ a.m. Conference on Sir John Lubbock's Bill for the "Training and Registration of Teachers."
Geologists' Association, University College, W.C., 8 p.m.
Archæological Institute, 16, New Burlington-street, W., 4 p.m.

Saturday, Jan. 8th...Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Prof. Dewar, "Atoms." (Lecture VI.)

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

JUVENILE LECTURES.

On Wednesday evening, the 5th inst, Mr. G. J. ROMANES, F.R.S., delivered the second of his lectures on "Animal Intelligence." In continuation of the subject of his first lecture, he referred to the habits of bees and of trap-door spiders, and then passed on to consider instances of the intelligence of the higher animals. He related anecdotes of fish, reptiles (including tortoises, turtles, frogs, and alligators), birds (more particularly noting the speech of parrots), and mammals, beginning with elephants, whose sagacity the lecturer thought had been somewhat overrated, passing on to cats and dogs, wolves and foxes, and ending with monkeys, whose habits he was now studying at his own home.

Dr. R. J. MANN, F.R.C.S. (the Chairman), in proposing a vote of thanks to the lecturer, related an instance of the intelligent speech of a parrot at a public meeting, and added that the human audience were not likely to prove less intelligent than this parrot, so he was sure that all the boys and girls present would join in heartily thanking Mr. Romanes for the two pleasant evenings they had spent together.

CANTOR LECTURES.

SOME POINTS OF CONTACT BETWEEN THE SCIENTIFIC AND ARTISTIC ASPECTS OF POTTERY AND PORCELAIN.

By Prof. A. H. Church, M.A. Oxon., F.C.S.

LECTURE III.—DELIVERED DECEMBER 6TH, 1880.

On Stoneware and other Wares Glazed with Salt.

Terra-cotta sometimes tends to pass into stoneware. A higher temperature of the kiln, and a larger proportion of vitrifiable material in the body, are necessary conditions. And, if iron and substances tending to produce opacity and colour be excluded, stoneware may further advance into hard-paste porcelain. But such transitions are associated with many intermediate conditions, and it is impossible to define strictly what is earthenware, what stoneware, and what porcelain. In the two latter materials there must, however, be a binding vitrified cement produced out of the constituents of the body at the high temperature of firing. But the nature of the ware produced will depend upon so many factors, that to predict the result of burning any material or mixture is impracticable. The clays which form the basis of all ceramic materials differ immensely one from the other, and in many directions. The silicates of alumina, of which they mainly consist, are not always identical, much opal is present in some, while imperfect kaolinisation and, consequently, a high per-centage of alkalies, characterise others; the proportion of iron forms another point of difference. The following analysis of different typical clays serve to illustrate the range of composition, but they by no means exhaust it:—

Percentage of	Stourbridge.	Watcombe.	Teignmouth.	Poole.	Cornwall.
Silica	66	58	53	50	46
Alumina	23	21	30	33	41
Alkalies, lime, magnesia	$\frac{1}{2}$	7	3	4	4
Oxide of iron	2	8	$2\frac{1}{2}$	$2\frac{1}{2}$	trace
Water	$8\frac{1}{2}$	6	$11\frac{1}{2}$	$10\frac{1}{2}$	9

It is particularly important to trace, wherever possible, the dependence on composition of the contraction on firing which clays undergo. It usually varies from 1 to 10 per cent. on the original volume. That silica, in most of its forms, reduces shrinkage has been long known, while the elaborate researches of Mr. George Maw, on the natural clays of the British strata, have given precision to our acquaintance with the effect of heat upon these raw materials of pottery, both in their native state, and when freed from coarse matter by washing.

In attempting to ascertain the relation between the constitutents of stoneware bodies and their outward aspect, one meets with difficulties often insuperable, through the insufficiency of records, especially as to the "Grès Cérames" of foreign origin.

It is, indeed, only within the last few years that chemical analyses, with any claim to accuracy, have been attempted of British ceramic materials and products, and our determinations are still all too incomplete. Naturally, the manufacturers of to-day, like those of a couple of centuries back, are not ready to divulge the recipes, even if their differences be apparently trivial, which experience has shown to give the most satisfactory results. The manuscript memoranda of Wedgwood, and the published notes of Enoch Wood, Simeon Shaw, and others, have, however, left some record of the materials employed by our Staffordshire white stoneware potters of the eighteenth century. And we have, happily, an extensive series of their ceramic productions still extant for critical study, and for analyses of materials and methods. It is evident that there was a progressive improvement in the materials and

modes of making stoneware in the seventeenth and early part of the eighteenth century. This progress was not exclusively localised in Staffordshire, but was, perhaps, more marked in some other centres of the manufacture. As to the district of the potteries, Shaw states that the body of "crouch ware" was successively made of—

1. Brick-earth and fine sand;
2. Can-marl and fine sand;
3. Grey coal-measures clay, and fine sand;
4. Grey clay and ground flint.

This last and most important improvement is attributed to Astbury, in 1720; the son of this Astbury introduced in 1725 (upon a cream-coloured stone body) a wash of clay and flint. The ground flints were used in lieu of sand, and amounted from 20 per cent. to 25 per cent.

Flint, like sand, increases the hardness and lowers the fusibility of the paste or body, by diminishing the relative proportion of alkalies present. Later on, Josiah Wedgwood further modified and refined the stoneware body. His jasper ware contained more than half its weight of barytes or heavy spar (barium sulphate), while the proportion of clay to ground flint remained the same as before. Translated into per-centages, one of Wedgwood's own early recipes becomes—

	Per cent.
Barytes	57·1
Clay	28·6
Flint	9·5
Barium carbonate	4·8

Other and later recipes for this barytic body are—

Barytes	45	45
Kaolin	18	10
Blue clay	26	15
Flint	11	12
Gypsum	0	2
Cornish stone	0	16

In this jasper ware, the barytes acts in more than one way; for not only does it constitute one of the refractory ingredients of the body, but it forms an infinite number of minute internal reflectors, displaying to advantage any colours which may have been incorporated with the vitreous substance of the ware. Sometimes to baryta must be attributed the chalky and opaque whiteness which is seen in jasper bodies.

The introduction of felspathic constituents into the stoneware mixture alters it in the direction of greater fusibility and translucency. Felspar and china stone are used for this purpose; so high a per-centage of china stone as 40 is not unusual. The great contraction or firing which such stonewares and semi-porcelains undergo, form a considerable drawback to their common employment.

Thus far we have been considering the body or paste of stonewares. Before passing on to the study of the remarkable process of glazing them, a method not adapted for, nor applicable to, other wares, the definition of stoneware, as given by Jacquemart ("Histoire de la Céramique," pp. 7 and 360), may be advantageously cited. He speaks of "les grès" as having a dense, very hard, sonorous paste, made from plastic clay, "dégraissé" by means of sand, silica, or pounded ware. He adds that they are usually glazed by means of salt, sometimes by felspar, forge scales, or pumice; sometimes by a mixture of silica, felspar, barytes, and a little lead. The single baking which such wares require lasts from four to eight days.

I will now turn to the glaze which constitutes so marked a characteristic of the majority of stonewares. It is peculiar, not only in its composition, but in its mode of application, its manner of formation, and its appearance. Into its composition scarcely anything enters but soda and silica; it is applied by means of vapour when the body to be glazed is at a high temperature; it is formed partly out of the silica of the ware and partly out of the vapour with which it comes in contact; it presents an appearance which differs from other glazes, not so much in gloss as in texture, or rather, in distribution on the surface where it has been produced. This texture reminds one of fine leather or orange-skin, but it varies in "grain" within very wide limits. The most characteristic specimens are not generally the most beautiful, and there is a tendency to excess or deficiency, and to inequality of glaze, when produced by the salt process, which causes great variations in the surface of a single specimen. The perfection of this glaze is sometimes reached on objects of common materials and ordinary workmanship, even on drain - pipes, filters, and chemical apparatus. In the white Staffordshire stoneware of the last century, it is frequently seen to combine perfect efficiency as a protective coating with that exquisite half-gloss which, without interference from its own excessive brilliancy on the one hand, or coarse irregularity on the other, brings out both the form and the decoration of the body. The exact nature of the most perfect condition of this salt glaze baffles verbal description, but this, at least, may be affirmed of it, that its individual particles, while sufficiently obvious to prevent a completely smooth appearance being produced, must not be distinct enough from each other to be numerable.

The chemical reactions concerned in the process of salt-glazing may next claim our attention. It will be convenient to speak first of the essential or primary part of the change. This may be divided into two stages:—

$$(a)\ NaCl + H_2O = HCl + NaHO;$$
$$(b)\ 2NaHO + nSiO_2 = NaO_2n\ SiO_2 + H_2O.$$

In *a* we have the vapour of common salt thrown into the furnace during the last stage of firing, meeting with water-vapour arising from the combustion of the hydrogen of the fuel, and present as a normal constituent of the common air to the extent of 1 to 1½ per cent. by volume. The two vapours react, producing hydrochloric acid and caustic soda, the former of which escapes almost completely, while the latter acts upon certain silicious constituents of the hot ware, and thus forms a sodium silicate and water. Questions arise as to the nature of the silicate thus formed, and as to the source in the body of the silica which it contains. Some experiments lead to the formula $Na_2Si_7O_{15}$ for the glaze, and seem to indicate that it is not all the aluminous silicates of the clay, but some of them, and part of the free silica, and any alkaline silicates present, with which the soda of the vapours combines.

A subordinate or secondary reaction occurs between the hydrochloric acid, produced in reaction *a* above, and any ferric oxide present in the clay

body; we may formulate this in the following expression—

$$(c)\ 6HCl + Fe_2O = Fe_2Cl_6 + 3H_2O;$$

or we may assume that the common salt vapours act directly upon the ferric oxide thus—

$$(d)\ 6NaCl + Fe_2O_3 + 3H_2O = Fe_2Cl_6 + 6NaHO.$$

If reaction *d* occur, there will be more soda to form additional glaze upon the ferruginous surface, while in both reactions, *c* and *d*, the ferric chloride, which is volatile, will yield, with water vapour, hydrochloric acid and ferric oxide, the latter then combining with the sodium silicate of the glaze to form a double silicate of iron and sodium. Thus, in the salt-glazing process, the iron of the body is brought in some measure to the surface, and contributes additional material to the glaze, while it imparts to it a brown hue. Impure clays, and those which are rich in lime, silica and alkalies, become much more highly glazed than a pure kaolin or china clay. Colouring materials with which the ware may be decorated act similarly. Even a wash of china clay upon a common clay will prevent the extra gloss, commonly formed on the latter, from being produced. Where red lead is mingled with the salt thrown into the kiln, first it is reduced by heat to protoxide, then lead chloride is probably formed, according to equation *e*, decomposed into lead oxide, according to *f*, and fixed on the ware as lead silicate, according to *g*:—

$$(e)\ 2NaCl + PbO = PbCl_2 + Na_2O.$$
$$(f)\ PbCl_2 + H_2O = PbO + 2HCl.$$
$$(g)\ PbO + 4SiO_2 = PbSi_4O_9.$$

Before I take up the study of the individual specimens before us, it may be well for me to say a few words as to the early history of glazing with salt in this country. The subject is obscure. A manuscript by Josiah Wedgwood, dated 15th January, 1765, gives particulars furnished by one Steel, a potter, then aged 84, who remembered the brothers Elers, the Dutchmen, at work at Bradwell. Steel was one of those who went out to see what was the matter when the dense fumes rose from their salt-glaze kiln on the addition of the common salt, and he stated that glazing with salt was first employed by the Elers. Wedgwood agreed with this view, and further assigned to them the introduction of lathe and engine turning and of alabaster moulds. The old story about the origin of salt-glazing, about 1680, through the boiling-over of some brine in an earthen pot, lacks confirmation. It is extremely probable that the brothers Elers did first practise salt-glazing in Staffordshire somewhere between 1688 and 1693, but we are bound to admit the possibility of the process having been used elsewhere in England at an earlier date. As early as 1671, two English patents were granted for making stoneware. One of these, dated 23rd April, 1671, was in favour of J. Ariens van Hamme; the other, dated 13th April, in the same year, was that of J. Dwight, of Oxford. It was for the "mistery of porcelaine or china," and of "stoneware, commonly called Cologne ware." Fortunately, we possess a considerable number of authentic—we may almost say, dated—specimens of Dwight's stoneware. Some of these are earlier than any pieces of Elers' manufacture, and yet exhibit all the characteristics of salt-glaze. The examples in the British and South Kensington Museums, all derived from the collection of Mr. C. W. Reynolds, may be cited as particular illustrations of my statement. But my own examination of a bust of Mrs. Pepys, and of a fine statue of Saturn (both, alas, now lost in the fatal fire of June, 1873, at the Alexandra Palace, when so many ceramic treasures perished), led me to the same result. The specimens discovered on the site of the Fulham works, by their present proprietor, Mr. C. J. Bailey, afford further confirmation of my view.

Thus far I have been directing your attention in succession to stoneware bodies; to the glaze with which they are commonly covered; and to the introduction of that peculiar method of glazing into this country. A few words as to certain salt-glazed stoneware vessels, to which an English origin is assigned by some authorities, may be fitly added now. These wares may be classified thus:—

Class 1.—Brown mottled jugs, often mounted in silver, bearing English plate marks of the Elizabethan period, 1558 to 1603. As "wasters" of these have been found in London, and as they seem to occur almost wholly in England, they, or some of them, were probably made in this country. If so, salt-glazing must be put back more than one century.

Class 2.—The narrow-necked jugs of brown-glazed ware, with a grotesque bearded head in front, known as "Bellarmines." These were certainly made by Dwight, of Fulham, but there seems no direct evidence to prove that any of them were made in England before the year 1671. Yet, if an English origin be accepted for some of the vessels belonging to class 1, there will be no difficulty in reaching a similar conclusion concerning examples of the present class.

Class 3.—Wide-mouthed jugs and cylindrical mugs, bearing applied medallions, with W. R., A. R., G. R., in front, and decorated with incised and applied ornaments, sometimes with cobalt blue and manganese purple upon the designs. These vessels are of drab or pale-brown or grey stoneware, and are salt-glazed. Those of early date, which are most elaborate and well finished in design and colour, can hardly be regarded as English, for the evidence of authentic examples, found at Fulham, does not point to any very high level of artistic excellence having been attained even there, towards the close of the seventeenth century, in this particular class of wares. But notwithstanding this limitation, I am convinced that some good pieces belonging to this third class were really of home manufacture. These are generally without colour, and of somewhat simple if not rude style.

Class 4.—This class consists of white stoneware jugs, usually of half-pint capacity, having a rough medallion in relief of W. R., A. R., or G. R. in front, and often further decorated with simple and rough leafage in dull blue. The glaze is smooth and not produced with salt. The body is not so hard as that of the preceding classes. These vessels are English, but the places of their manufacture can only be conjectured from documents and from "finds" of wasters. Three or four places within the London district have been suggested as the sites of the pot-works where these jugs were made,

but the question is one on which I must not further dwell just now.

Leaving these matters, about which a considerable degree of doubt still hangs, I will now pass on to the study of the most beautiful of the finer original wares ever made in this kingdom, a ware which is peculiar to England and to Staffordshire, and upon which, for about 80 years, an extraordinary amount of skill was exercised. It is remarkable, however, that the Staffordshire potteries no longer remain the seat of the salt-glazed stoneware manufacture. But in the period of 1688 (or 1693) to 1780, an immense quantity of "useful" ware of this kind was made in Burslem and "the Potteries." The question is naturally asked, "Did the Brothers Elers introduce and make it?" That they made this ware we have an argument in the identity of much of the ornament on "red china" of Elers' type with that on early white salt-glazed ware. We have the argument derived from the Continental "tincture," or feeling, which is observable in the impressed and applied ornaments of the ware. We have a consensus of local tradition almost without exception. The authority of Wedgwood, and of other potters of the middle and latter part of the eighteenth century, tends in the same direction. Enoch Wood's ceramic museum contained a large collection of this Staffordshire stoneware, described in Ward's "Stoke-upon-Trent" (1843) as including examples of "the Dutchmen's superior skill." One of the specimens was a pint jug, bearing a medallion of King William III., in relief, accompanied by flowered ornaments stamped in metal moulds; the body was of ash-coloured marl. This jug is spoken of as the earliest specimen of salt-glaze in the Wood collection. It is a great pity that this museum was dispersed; some of the specimens are fortunately preserved in Jermyn-street, and at South Kensington; some are in Edinburgh and Dublin, but the best were given by Enoch Wood to Dresden, while others form part of a private collection in the Potteries. Enoch Wood, however, according to the catalogue of his collection, deemed the white and grey stoneware pieces to have been imported from Germany or Holland. But there is irrefragable evidence to the contrary. As to vessels of 1700 and later, there is no dispute. Enoch Wood possessed a number made of Staffordshire clay, marbled with manganese, glazed with salt, and bearing medallions of Queen Anne; he speaks of these as "chased." Then were introduced slips of Devon or Dorset clay to line or wash or ornament the wares; afterwards the admixture of native clays with flint, then metal moulds, and lastly those of plaster of Paris. We are enabled from these particulars, and from the data which I furnished at the opening of this discourse, to construct a kind of rough chronological division of Staffordshire work in salt-glazed stoneware:—

Period I.—Prior to 1720—Impressed and applied ornaments; ash-grey and dull bodies.

Period II.—1720 to 1740—Flint introduced into the body; fine sharp work.

Period III.—1740 to 1760—Extensive use of coloured enamels in decorating the salt-glazed surface.

Period IV.—1760 to 1780—Prevalent ornamentation of basket and perforated work.

The decoration of the ware comprised a great variety of processes, which may be summarised in the following scheme:—

Form.
- Engine turning.
- Incised work.
- Applied ornaments cast in moulds.
- Pressed or moulded work.
- Slip-cast in absorbent moulds.

Colour.
- Ash-body with white-wash cut away partially, or with applied ornaments.
- Zaffre or manganese powdering previous to glazing.
- Enamelling over glaze.
- Transfer printing over glaze in iron red or gold violet.
- Oil gilding and japaning.

It should be noticed that the whiteness of the finer specimens of old Staffordshire stoneware is due in some measure to the wood fuel employed for burning them, and to the protection of saggars. Mr. Doulton has kindly refired this old plate for me without a saggar, and in one of his ordinary stoneware kilns. It stood the test well, not having suffered in form by the fiery ordeal to which it has been subjected. But the colour of the surface has been darkened by irregular brownings of the glaze. The trial was a severe one, not only for the reasons previously given, but because when a piece of stoneware has been once glazed with salt the fusible matter then present on the surface is likely to destroy the refractory character of the body on a second firing.

[The lecturer proceeded to point out the physical and artistic characters of a large series of old Staffordshire specimens on the table.]

The modern revival of English stoneware has been so fully dwelt upon in this hall by Mr. Sparkes, that I need do little more than name it. But it is impossible to pass over quite in silence the marvellous spirit with which Mr. Henry Doulton, and those whom he has associated with himself in the work, have developed an art manufacture of a very high order of excellence out of a large pot works, long devoted to the production of very useful, but very humble wares. He has pressed into his service every element, tried and untried, which could be brought into the manufacture, and the results are widely known and appreciated.

[The lecturer proceeded to point out the decorative and physical characteristics of a select series of pieces of Doulton's stonewares, including those without glaze, those having a glaze essentially felspathic, and those glazed with salt. He dwelt with especial emphasis upon those specimens which showed beautiful effects of colour and texture due to accidental flowing, mingling, &c., of colours, and to the contrast between glazed and unglazed, or partially glazed surfaces.]

The flattery which shows itself in imitation has followed the stoneware revival of Messrs. Doulton. The productions of Mr. C. J. Bailey, of Fulham; Messrs. Stiff and Sons, of the London Pottery, Lambeth; and of Mr. R. W. Martin, of Southall Pottery, resemble the pieces emanating from Messrs. Doulton's works in character and material, but are, perhaps, of a less sustained order of merit. But, whatever their source and spring, and however limited in the range of their artistic elements, the products of all the potteries which I have named present many features of value and interest, and

constitute a remarkable tribute to the splendid and well-deserved success of the originators of this new art-manufacture.

No lecture on stoneware could omit all reference to the productions of Continental potteries. But the brief limits of the time remaining at my disposal forbid more than a hasty glance at a few of the more characteristic kinds of German and French stonewares. The study of the specimens in the South Kensington Museum and in the British Museum will enable any one interested in the subject to discern the peculiarities and, I may add, the merits which distinguish the four most prominent kinds :—

Class I.—White canettes, glazed and unglazed, belonging to the latter half of the sixteenth century, and resembling in body the white Staffordshire stoneware of the first period. They are finely decorated in relief.

Class II.—Yellow and brown short jugs, generally with acorn and oak leaf patterns in high relief, and referable to the close of the fifteenth and beginning of the sixteenth century.

Class III.—Jugs, tankards, &c., of greyish yellow body, variously decorated with incised and applied ornaments, and frequently further enriched with cobalt-blue and manganese-puce ; often attributable to Cologne and Aachen districts. Similar productions have been traced to Beauvais, in France.

Class IV.—Tankards, jars, and other vessels of brown stoneware, with dark brown or black glaze, and decorated further (in the enamel kiln) with enamel colours, sometimes gilt also. They are often of Franconian origin ; Jacquemart gives as a locality of this manufacture, Creussen, in Bavaria. Sometimes the wares of this class have a "painty" look, but the simpler decoration which they occasionally bear, of a white stanniferous enamel on a purplish black ground, is charming.

[The lecturer concluded by describing the chief characteristics of the foreign stone wares which he had brought to illustrate his discourse, pointing out the causes of the commendable features of the old foreign specimens, and how the modern German reproductions fail to satisfy the feeling for colour and texture.]

MISCELLANEOUS.

POSTSCRIPT TO MR. A. J. ELLIS'S PAPER ON "THE HISTORY OF MUSICAL PITCH," AND ITS APPENDIX.

My paper on "The History of Musical Pitch" is printed in the *Journal of the Society of Arts*, for 5 March, 1880, pp. 293—336, and the Appendix, containing a correction of the principal errors of the press in the original paper, and several additions, is printed in the *Journal* for 2 April, 1880, pp. 400—403. In reprinting these for private circulation, I was able to make a few corrections, and, at the last moment, an important addition respecting the pitch of Koenig's Ut_3, App., p. 401, c. 2, which I am desirous of printing with greater detail in the *Journal*. I have also been able to make some experiments on the influence of temperature on the pitch of harmonium reeds, which, as I stated (Hist. of M. P., p. 301, col. 2, end of art. 19), was unknown when my paper was read, and is important for the use of Appunn's tonometer. I have also received some corrections respecting the Temple organ, and an important addition respecting the Strasburg Minster organ. These and one or two other points will be given in this postscript, which has been delayed by the press of other work.

Corrections and Additions.

(1.) *Handel's Fork.*—Page 293, col. 2, note, the Rev. G. T. Driffield, owner of Handel's fork, has removed from the rectory of Bow to that of Old, near Northampton.

(2.) *Influence of Temperature on the Pitch of Harmonium Reeds.*—Page 301, col. 1, last paragraph of art. 19, l. 4, I stated that one of the drawbacks to Appunn's reed tonometers was, that "their variation with temperature was unknown." I have now been able to make at least a close approximation to its determination. In finding the pitch of every reed in Appunn's instrument, as described on p. 301, col. 1, in November, 1879, I worked at a variety of artificial temperatures, from 53° F. to 60° F., all carefully recorded for each reed, together with the numbers of the Scheibler forks with which the beats were taken, and also the precise numbers of beats observed. It occurred to me that by measuring about a dozen of the same reeds of very different pitch, at a much higher temperature, by means of the same forks as before, I should have sufficient data for calculating the amount of alteration for a reed of a given pitch, when subjected to a known variation of temperature. I accordingly took the pitch of a selected number of reeds on one day in July, and two days in September, 1880, at constant natural temperatures of 71½, 73, and 79 deg. F. respectively. I had in each case to allow for the alteration of the pitch of the forks by temperature, and then to determine the pitch of the reed at the higher temperature, and finally to divide the result by the pitch of the same reed at a lower temperature, and by the number of degrees of difference of temperature. As at least ten observations were taken with each fork, and at least two, sometimes three, forks were used for each reed, and the means of each were taken for safety, the calculations were rather lengthy. The resulting figures will appear in a paper in the Proceedings of the Royal Society, where also has appeared my paper on Musical Beats (vol. xxx., pp. 520—533) in which I have given some of the details of my examination of Appunn's tonometer. The mean result is that both tuning forks and harmonium reeds flatten by heat, and sharpen by cold ; but while forks alter by about 1 vib. in 20,000, the reeds alter by about 1 vib. in 10,000 (that is, twice as much) for each degree Fahrenheit. This correction should therefore be also made in taking pitches by Appunn's tonometer. Practically if a fork, an harmonium, and an organ were in exact unison, as A440, at 59° F., then if the temperature were to rise 20° F., as is not unfrequently the case during an evening concert, the fork would flatten to A439·56, and the reed to A 439·12, whereas the organ would sharpen to A 449·15, which would be terribly out of tune with the harmonium, so that no music should be written, as music has been written, for organs and harmoniums to play together.

(3). *French Pitch at Covent-garden Opera in* 1880.—Page 314, col. 1, after line 7, add—At Kuhe's concert on the 12th of June, 1880, Mr. Hipkins observed that the Covent-garden opera band was in exact unison with his piano there used, which piano had been carefully tuned in French pitch. Quite at the close of the Covent-garden opera season of 1880, he observed that the band had sharpened by three or four vibrations. Hence, the intention to use French pitch was fairly carried out, and the effect of French pitch in operas was well exhibited.

(4). *Handel's Pitch.*—Page 319, col. 2, line 20 from bottom, correct the date of Mr. Brownlow's letter to

21 May, 1858, instead of 1848. Mr. Driffield did not own the fork till 1857.

(3.) *Pitch of the Ancient Concerts at Hanover-square Rooms.*—Page 320, col. 1, l. 4 from bottom of first paragraph, it is stated that in 1805 the organ of the Hanover-square Rooms was built by Elliott "in the usual flat pitch of the period (that is about A 422·5.)" The fork to which that organ was originally tuned was subsequently found by Messrs. Hill, the successors of Elliott, and kindly lent to me for measurement. Hence on p. 321, col. 1, alter the entry A 422·5 to (1) A 424·9; and insert as a new entry :—

(1) MA 424·9, MC 505·3, 1 D 568·3 measured (Ellis) 1880. Old D-fork of Elliott's, to which he tuned the organ he built for the Hanover-square Rooms, lent by his successors, Messrs. Hill, showing that the estimate under (1) A 422·5 near the end (which see for other particulars) was only V 2·5 too flat. If we calculate from 1 D we find 1 EC 506·3, but if we calculate from MA we find 1 EC 505·3.

Insert among concert organs, p. 334, col. 2, "1805, Elliott, Hanover-square Rooms, S 2·39, A 424·9."

(5.) *Organ of St. Mary's, Shrewsbury.*—(2) MA **433·6**, l. 2, *for* Byfield and Green, *read*, John Harris and John Byfield, 1729, the makers names originally painted on the organ, altered by Blyth, 1826, and by Bewsher and Fleetwood, 1833, *and in line* 3, *for* 1846, *read* 1847. This information was supplied by Mr Hiles, 51, Elsham-road, Kensington, W. Make the corresponding change on p. 331, col 2.

(7.) *Fork of Society of Arts (copy.)* Page 328, col. 2, entry (4) FA **445·0**, *for* C 332·8 read C 532·8.

(8.) *Strasburg Organ.*—See p. 306, col. 2, l. 20, from bottom, and p. 317, col. 1, l. 11 from bottom.—There is here an attempt to estimate the pitch of A. Silbermann's celebrated organ at Strasburg, which I inclined to put at A [illegible]. After much correspondence, and a long delay, I have at last succeeded in obtaining the the pitch of this interesting instrument, through the kindness of Mr. Hipkins, in London, and of Miss Sydney Austin, M. Stockhausen, Director of the Conservatoire, Messrs. Hug frères, musicsellers, Wetzel, the organ builder, and the Abbé Schaffer, organist of the Minster, all of Strasburg. Hence, insert as a new entry on p. 271, col. 2, immediately after A 392·2 :—

A 393·2, MC 470·4, JC 471·8, 1 EC 467·6 measured, S [illegible] (Stockhausen and Ellis) 1713-16. Great organ at Strasburg Minster, built by A. Silbermann. A fork was sent to Strasburg by Mr. Hipkins, and the beats it made with the 1 C of the organ were counted by M. Stockhausen at 16·5 deg. Réaumur. This fork was then measured by me, and the direction of the beats being known by other forks, the pitch of the 1 C at this temperature was determined. It was then reduced to the pitch at 59° F. in the usual way. The Abbé Schaffer informed me that the temperament is now equal, this tuning having been introduced about 1850 by M. [illegible], when the "solo organ" was increased and placed above in the vault of the church. After the Franco-German War, during which the organ was partly destroyed, it was restored and tuned equally by M. Wetzel. But in every case the pitch of A was preserved as it was in the original church pitch of A. Silbermann. Then, as 1 C was measured, 2 FA was calculated from it as an equal minor Third lower, which therefore, gave the original pitch, A 393·2, whence the original meantone C 470·4, and just C 471·8 were calculated. The result is probably correct to one or, at most, two vibrations. The pitch is S 1·79 flatter than French pitch, which is about halfway between S 1·50 (or the three-quarters of a tone estimated by ear by M. Stockhausen and M. Wetzel, and S 2·0 (or a whole tone, as estimated by Mr. Hipkins), showing that their estimates were both tolerably correct, for musicians seldom estimate closer than to a quarter of a tone. This organ labours under the defect—which, according to Mr. Davison (of Gray and Davison), was not unfrequent in old organs—of having unequal force of wind, entirely out of the control of the player, and often altering individual notes to the extent of a quarter of a tone. There is an intention to contruct a bellows with equal pressure, and re-tune the organ thoroughly, in strict equal temperament, when funds allow. It will be observed that this is a B French-foot-organ, as a mean semitone flatter than its MC 470·4, calculated above, gives MB 450·2, which is almost exactly 450·5, or Bédos's C, with a pipe one French foot in length (see p. 317, col. 1, MA 376·6). It is the most exact specimen of a B French-foot-organ which I have found, and not only confirms the pitch assigned to Bédos but the accuracy of the present determination. This pitch also agrees, within a vibration, with Euler's clavichord, A 392·2, of nearly the same date (1739), and with Dr. Smith's determination of the pitch of Trinity College organ, after flattening, MA 395·2. The close agreement of the pitch of the organs cited under *Church Pitch, Low*, to which this belongs, puts the actual use of this pitch in various countries 150 to 200 years ago beyond any reasonable doubt.

(9) *Comparison of Scheibler's, McLeod's and Mayer's Measures.*—Appendix, p. 401, col. 2, l. 32, *omit* "I found also," *to the end* of the table, and insert the following, which results from measurements made subsequently to printing the Appendix, but is given in my private reprint :—

Making the corresponding corrections, the results of Prof. Mayer's measurements are given in the column "Mayer, E." below. Afterwards Prof. McLeod measured the forks with the points on, and then with the points off, each fork remaining unmoved in the vice for both measurements. It was thus discovered that the effect of the added points was very small indeed, and that the chief difference generally arose from some loss the forks had sustained in their journey to America and back, as shown below, the numbers being fractions of V (or the numbers of vibrations in a second).

Forks.	Conserv.	Tuileries.	Feydeau.	Versailles.	Marloye.
Loss	·0015	·165	·0205	·0285	·014
Points ..	·0475	·035	·022	·022	·021
Sums ..	·049	·200	·0425	·0505	·035

Adding these sums to the values found by Prof. Mayer, we find his measurement of the forks in the condition in which they were when measured by Prof. McLeod and myself at 59° F. The results are given in the column, "Mayer, McL."

Name of Fork.	McLeod.	Ellis.	Mayer, E.	Mayer, McL.
Conservatoire....	439·55	439·54	439·48	439·51
Tuileries........	434·33	434·25	434·26	434·33
Feydeau	423·02	423·01	422·91	422·98
Versailles	395·83	395·79	395·77	395·78
Marloye	255·98	255·96	255·98	256·02

The second table on p. 300, col. 1, which was left incomplete, must be supplemented accordingly. Page 401, col. 2, l. 11 from bottom, *for* two *read* three, *and* l. 7 from bottom, *for* his own fork, V 256·31, *read* his own forks, V 256·28, 256·31, *and* p. 402, l. 2, *for* 9 *read* 10. The above corrections were made in the private reprint.

(10.) *Koenig's New Standard Fork.*—Page 402, col. 1, after the paragraph ending on l. 4 add the following :—

The result of the various measures of Koenig's Ut_3, given on p. 401, col. 2, near bottom, was to make it extremely probable that this fork, which was held to give V 256, really gave V 256·28 at 59° F. = 15° C., which was the temperature at which it was supposed to have been constructed, although Koenig had never stated the temperature for which his forks were correct. In the table on p. 301, col. 2, I had calculated the harmonics of V 64·07, or two octaves lower, on this supposition (to which should have been added the 12th harmonic, or Sol_4 768·84, which was accidentally omitted.) Last July, in measuring a series of forks constructed by Messrs. Valantine and Carr for Lord Rayleigh, and intended to give V 128, 160, 192, 256, 320, 384, 512, 640, 768, 1024, 1280, 1536, 2048, I had an opportunity of carefully remeasuring all Koenig's harmonic forks belonging to the Royal Institution, and I found the numbers of vibrations agreeing exactly with those in the table referred to. Since no reasonable doubt could be felt as to the correctness of these determinations, it would follow that Koenig's fork was not intended for a temperature of 59° F, but for one of about 80° F.

Now, on p. 300, col. 2, l. 11, I stated that I had heard that Koenig had "invented a new and exceedingly accurate counting instrument," of which, at the time of reading my paper, I had seen no description. Prof. McLeod was enabled to lend me Koenig's paper, "Investigations of the Vibrations of a Normal Tuning-fork" (*Untersuchungen über die Schwingenungen einer Normalstimmgabel*, from the *Annalen der Physik und Chemie*, 1880, *Neue Folge*, vol. 9, pp. 394—417, edited by G. Wiedemann, Leipzig) in time for me to insert a short postcript, on 1 May, 1880, in my private reprint, showing that these researches had removed all trace of discrepancy between him and me, and that now the extremely different methods of Scheibler, McLeod, Mayer, and Koenig (to which we may add Appunn when properly corrected) all led to the same result; so that we are at last able to determine pitch with great precision, and all the determinations made by myself in my "History of Musical Pitch" may be trusted as correct. Dr. Koenig has subsequently kindly presented me with a copy of this paper, and a photogaph of his new instrument. His process and results are as follows:—

First, he constructed a very large tuning-fork, giving very nearly 64 double vibrations in a second. The tang or handle of this fork was firmly fixed permanently in a vice, forming part of a solid stand, kept truly horizontal by three adjusting screws, and supporting a frame containing a clock, which was wound in the usual way, but was regulated by the vibrations of the fork, instead of by those of a pendulum. Its second hand, therefore, was made to register 128 single vibrations in a second. By the side of this clock was another, a chronometer, giving mean time accurately, so that it was easy to see whether the tuning-fork clock had lost or gained in a given number of hours. As each hour of the tuning-fork clock corresponded to 60.60.64 = 230,400 double vibrations, and 60.60.128 = 460,800 single vibrations, it became comparatively easy to calculate, by a careful comparison of the two clocks, the exact number of double or single vibrations made by the fork in one second, that is, its pitch, to a degree of accuracy hitherto unknown. Each prong was furnished with micrometer screws, carrying heavy knobs, and, by screwing these up and down, the pitch could be varied, and finally accurately adjusted to V 64. A long thermometer hangs from the clock between the prongs without touching them, showing accurately the temperature of the air, and, after a sufficient time (determined by careful observations) of the fork itself, which, being a heavy mass of metal, took some time to show any effects of a change of temperature. To one of the prongs was attached the object glass of a microscope, of which the body and eye-piece were attached to the frame, thus forming a Lissajous vibration microscope. The weight of this object-glass was balanced by a steel mirror on the other prong, added for the purpose of producing the Lissajous changing figures, by means of which forks can be accurately tuned to one or two Octaves, or to a Third or Fourth, or even Sixth, above the normal fork. On account of the slowness with which the fork followed the temperature, so that, when depressed by V 2, by heating, it took from two to two and a-half hours to thoroughly recover its former rapidity, it became necessary to operate as much as possible in a constant temperature. But there were great difficulties in keeping up an artificial temperature day and night. Large underground vaults were too cold, being only 12 C.= 53·6° F. in Paris, where the experiments were conducted. Dr. Koenig therefore selected 20° C.=68° F. as his normal temperature, and conducted his experiments in a very large, lofty, and completely closed room, in which temperature altered but slightly, so that the thermometer from morning till night showed scarcely any changes, especially in sunless days, of which he had abundance in Paris in 1879, and he obtained six days in June, and one in September, in which he was able to tune the fork to V 64, at 20° C., during four to eight hours. By these means he obtained, for the first time, an absolute standard for future deductions.

Then he tuned, by the Lissajous figures, another fork to V 256 at 20° C. = 68° F., and by the same process ascertained that its vibrations were absolutely isochronous, which is not always the case when the fork is attached to a resonance-box. Although, in my own experiments, I was not able to find any sensible amount of change which might not be fairly attributed to rrors of observation, Dr. Koenig, by the application of the vibration-microscope, was able to detect very small differences, amounting to V ·0167 in some cases, an amount absolutely inappreciable by ordinary methods of observation.

Dr. Koenig made a series of most important observations on the influence of temperature upon the pitch of tuning-forks, and his conclusion was that "we may say, quite in general, that the number of vibrations made in a second by a tuning-fork varies by one in 8,943 vibrations for one degree Centigrade" = one in 16,097 for 1° F. But different forks are affected differently, and, as his standard V 256 at 20° C. = 68° F. varied by V ·0286 for 1° C, or V ·016 for 1° F., it altered by one in 16,000. The different determinations of the variation of tuning-forks by temperature hitherto made are as follows:—

One in	17,650 or 16,970 by Cavaillé-Coll	for 1° F.
,, ,,	20,000 or 16,670 by Scheibler	,,
,, ,,	20,250 or 18,000 by Kayser	,,
,, ,,	18,280 from 59° to 175° F. by A. J. Ellis	,,
,, ,,	20,490 by Prof. McLeod	,,
,, ,,	22,000 by Prof. Mayer	,,
,, ,,	21,000, as the mean of the two last,	,,
,, ,,	16,097 or 16,112 or 16,000 by Dr. Koenig	,,

The differences for the same observer, arise from the use of different forks, and Dr. Koenig's are founded on the longest series of careful observations; so that, for his forks, his numbers—or, say, one in 16,000 for each degree Fahrenheit—should certainly be adopted.

Dr. Koenig then took his old standard fork Ut_3, intended to give V 256, and comparing it with his new standard at 20° C. he found that at that temperature it gave V 256·1774. Reducing this to 15° C. = 59° F. we have to divide by 16,000 and multiply by 5, giving V ·144 which has to be added, so that according to Dr. Koenig's own reckoning, his Ut_3=V 256·3215. But using the co-efficient of one in 21,000 for 1° F. by which I had calculated (p. 297, col. 1, line 23 from bottom), we should have to divide by 21,000 and multiply by 9, giving V ·1098 to be added, and giving the result V 256·2872. Either result, 256·32, 256·29, differs imperceptibly from the 256·28 at which I had arrived by the measurements of 10 different copies (app. p. 402, col. 1, line 2). Hence all discrepancy between

him and myself ceases. As 256 ÷ 800 = ·32, and 256 ÷ 900 = ·28, we can readily reduce Dr. Koenig's old standards to 15° C. = 59° F. by adding the 800th or 900th part. Taking the coefficient as one in 16,000 for 1° F. according to Dr. Koenig's determination, and the value at 59° F. = V 256·32, we should find that the temperature at which the fork would give V 256 would be 79° F., which agrees with Koenig's 26·2° C. = 79·16° F. Taking, however, my value V 256·28, and my coefficient of one in 21,000 for 1° F., we should find the temperature 80·8° F. In this particular case no doubt Dr. Koenig's determination of the coefficient as one in 16,000 for 1° F. should be assumed. The differences are extremely small, and depend entirely upon the uncertainties involved in the determination of the influence of temperature on forks. To avoid the trouble of calculating the correction for temperature, Dr. Koenig has affixed an apparatus to the end of his standard fork which may be adjusted to temperature, and will then secure V 256 at all temperatures.

Dr. Koenig proceeded to find the real pitch of the French diapason normal in the Conservatoire (see p. 323, col. 2, under A 435·4). He first constructed, by beats at 20° C. = 68° F., a fork V 5 sharper than his new standard, V 256, giving V 261 at 20° C.; then, by Lissajous' figures, he constructed a fork forming the exact interval of a major sixth, or 3 : 5 with it. This was V 435, at 20° C., but the intentional pitch of the diapason normal was V 435 at 15° C., and the fork just constructed would give V 435·243 at 15°, according to Dr. Koenig's calculations, where he assumes the coefficient as one in 8,951 for 1° C., or one in 16,112 for 1° F. Hence he constructed by beats a third fork, V ·243 flatter than the former, and obtained a real V 435 at 15° C. (such a fork Koenig had already constructed, unintentionally, and probably not quite so truly, see p. 323, col. 2 (6), A 435·0). This new fork he took to the Conservatoire, and left it for some days beside the diapason normal, in order that both might acquire the same temperature, and then, taking the beats, he determined the diapason normal as V 435·45, but says he could not feel absolute certainty, as the diapason normal would not give beats for more than 20 secs., owing, he thinks, to the action of the resonance box to which it is attached, so that for perfect accuracy it would be necessary to remove it. But, he adds, "Such extreme accuracy would not be of very great interest, because the experiments by which its pitch at 15° C. was determined, have not been published." The statement of the method used, which I have given, p. 323, col. 2, under A 435·4, was made on the authority of M. Cavaillé-Coll. I had previously endeavoured, without success, to learn the method from M. Lissajous, who was responsible for the pitch, but is now dead. This determination, V 435·45, made with such immense care and trouble, agrees almost precisely with mine, V 435·4, but as no provision had been made in the measurements by Mr. Hipkins and my son, for bringing the measuring fork to the temperature of the diapason normal, the process was in no respect so trustworthy as Dr. Koenig's. The near agreement of the result, however, tends to confirm the accuracy of my determinations of pitch. It is impossible to read Dr. Koenig's paper, which I have just summarised, without feeling the utmost confidence in his results, and admiration for his ingenuity, accuracy, and perseverance.

(11.) *Compass of Voice.*—Page 420, art. (3), l. 7 from end, *for* ½ F [illegible] *read* ½ F [illegible]. Corrected in my private reprint.

(12.) *Lavenham Bell.*—App. p. 402, col. 2, art. (7), l. [illegible] from end, omit *from* Mr. Hermann Smith *to the end* of the paragraph, and insert (the correction was made in my private reprint, after Mr. Lewis had compared a measured fork I sent him, with the little harmonium from which he had estimated the pitch):—

Mr. Lewis, the organ builder, found the famous old tenor bell at Lavenham (16½ miles W.N.W. of Ipswich), date 1625, meant to be and called D, to be 2 D 288·4; giving MA 431·3, which would be rather sharper than Harris's A 428·7 at Newcastle-upon-Tyne (p. 322, col. 1), and is interesting, as occurring in the earliest days of mean pitch, and before English organs had been smashed by the Puritans, 1644—6.

(13.) *Temple Church Organ.*—The indications in Appendix No. 9 (p. 402 of original, and p. 403 of reprint) contain several errors, and should be replaced by the following, in which the parts in inverted commas are arranged from communications from Messrs. Forster and Andrews, organ builders, Hull, who last rebuilt the organ. Insert on p. 327, col 1, after *A 444·3 :—

*(2) A 444·3, B *flat* 471·4, B 498·6, C 529 all measured. (Ellis), 1880, London; Temple Church organ, after the organ had been rebuilt in 1877-8, by Messrs. Foster and Andrews, who found the pitch "to be a good shade flat to the Society of Arts fork, which pitch is still retained." The fork mentioned was a copy by Metzel, and was measured by me at C 532·2, which is perceptibly sharper than the existing C 529, agreeing with above. "No transposition of pipes was made by Messrs. F. and A. during the rebuilding. The organ was originally in the eastern arch of the round church, whence it was removed in 1840-41 by the Mr. J. C. Bishop, (d. 1855), and re-arranged and erected in 1843 in the new chamber, where the present instrument stands, the glass being taken out of a window in the choir, and a new organ room constructed. On commencing the musical finishing, the whole of which was done in the church and on the old sound boards" (consequently retaining the old quarter tones, E *flat* and D *sharp*, A *flat* and G *sharp*, as originally at Durham, see p. 330, col. 1, last line), "the pitch was found to be very sharp, too sharp by more than a quarter of a tone, so that the transposition of one pipe was not sufficient to make it equal to the pitch then in use, and hence, on account of the quarter-tones, Mr. J. C. Bishop determined to transpose *two* pipes upwards, and insert two new pipes in each stop. This work was done by Mr. Forster, sen." Now here arises a difficulty. Mr. C. A. Bishop (son of Mr. J. C. Bishop) believed that his father always used "Smart's pitch," which, in 1843, ought to have been A 433, MC 518, see p. 322, col. 2, but may have been Smart's old pitch, which was the original Philharmonic pitch, see p. 320, col. 2, MA 423·7, C 506·8. This agrees with Mr. Clarke's statement that the Temple organ was in exact unison with Handel's fork, see p. 319, col. 2 (1) A 422·5, l. 8, but then Mr. Clarke's statements respecting the pitch of the ancient concerts as being a whole tone above this pitch, have been entirely discredited (see last lines of same entry). Messrs. F. and A. say that the organ was, in 1843, "finished to a fork supposed to be 512." But, considering that at about this time C 524·8 was believed to be C 512 (see p. 326, col. 1, A 441·3), which would be manifestly far too sharp, possibly C 518 or C 507, might also have been supposed to be C 512. It is clear, however, that the organ was lowered by more than a quarter of a tone. If we take Mr. Clarke to be right (and he could hardly be much wrong in a unison, although liable to errors arising from unstated temperature), Mr. J. C. Bishop left the organ at A 422·5 MC 505·4, having probably found it at A 441·7, B. Schmidt's Hampton-court pitch (p. 326, col. 1), which is S ·77 sharper, that is, just between a quarter and a half tone, or thereabouts. This supposition seems to reconcile all the statements best. If we took Smart's second pitch, used in 1843, of A 433, it would beat too strongly with Handel's A 422·5 (except in very hot weather indeed, upwards of 80° F.) for any reasonable ear to suppose they were identical. This second pitch would also give as an original, about A 454·2 (see p. 329, col. 1), which was not likely to have been any pitch used by B. Schmidt (see table on p. 331, col. 1, and the discussion under A 474·1). "The organ received new sound boards from the late Mr. Robson, about

1852," that is, the quarter-tones were then abolished, "and many new stops by Schulze and Robson. The pitch was then raised by Robson," to its present state A 444·3, which, by the above discussion, was probably very nearly its original pitch, "but not sufficiently for the stops made, and finished in Germany by Schulze, as may be seen on examining the pipes now in use." The pipes, when measured, were not in precise equal temperament, which would give A 444·3, EB *flat* 470·7, EB 498·7, EC 528·4, or C 529, EB 499·3, EB *flat* 471·3, EA 444·8.

With regard to *St. Paul's organ*, which Mr. Clarke also stated to be in unison with Handel's fork (p. 319, col. 1, A 422·5), Messrs. Forster and Andrews say that, "it was not altered in pitch by the late J. C. Bishop, but had been made flatter some years previously to 1839, as it was then stated, by Allman and Nutt. Every metal pipe in the organ had been pieced, even to the small mixture pipes, but at that date there had been no transposition of pipes." This makes it probable that St. Paul's, the Temple, and Hampton Court, were all originally at the same pitch, about A 442, MC 529.

(14.) *Belgian Army Military Instrument Pitch.*—App. No. 10, p. 403. Omit the passage, l. 15, "Hence, as the copy," . . . to l. 20, "more probable," which was printed before Dr. Koenig's correction of his own forks was known, and insert:—

The large copies I measured were A 451·7, at 59° F. Koenig must have measured by his old standard, so that, adding one in the 800 (see above, No. 10), we obtain V 451·56 at 59° F., which agrees so closely with my measurement, that the difference may arise from mere errors in copying by ear, or else Koenig may have contented himself with giving the nearest number of complete single vibrations, and thus called SV 902·25 SV 902, which would account for the difference.

To the end of this paragraph, App. 10, add, as in my private reprint:—

M. Victor Mahillon also says that the so-called fork of the Belgian Guides (see p. 330, col. 1, A 455·5), properly speaking, never existed. The pitch of A was occasionally given by M. Bender on a small clarinet, on which he played, and such a pitch is, of course, very uncertain. Mons. C. Mahillon, however, possessed a fork taken from it, which was at lowest A 456.

(15.) *Schulze's Tynedock Organ.* Page 403, App. 11, l. 13. Omit "For a similar pitch" to the end of the paragraph.

The above are all the additions and corrections that I have as yet found it necessary to make. In conclusion, I beg to express my thanks to the Society of Arts for awarding me a silver medal for my "History of Musical Pitch."

Alexander J. Ellis.

25, Argyll-road, Kensington, W., 29 Dec 1880.

OBITUARY.

Dr. Stenhouse, F.R.S.—John Stenhouse, LL.D., the eminent chemist, died on the 31st December, 1880, in the seventy-second year of his age. He was a native of Glasgow, in which city he lived for many years. On the occasion of the failure of the Western Bank of Scotland, which deprived him of his fortune, he came to London, and was appointed Lecturer on Chemistry at St. Bartholomew's Hospital. This appointment he was obliged to resign in 1857, on account of a severe attack of paralysis, which disabled him. He succeeded Dr. Hofmann, as non-resident assayer to the Mint in 1865, but in 1870 this office was abolished by the Chancellor of the Exchequer (Mr. Lowe). Dr. Stenhouse was awarded a Royal medal by the Council of the Royal Society in 1871," for his researches on the lichens, and their proximate constituents and derivatives, including erythrite, and for his researches on the action of charcoal in purifying the air." In 1854 he read a paper before the Society of Arts, "On the Deodorising and Disinfecting Properties of Charcoal, with the Description of a Charcoal Respirator for Purifying the Air by Filtration," and in 1861 he was elected a member. Besides the charcoal respirator, he was the inventor of a charcoal ventilator for sewers, and a process for rendering fabrics waterproof by means of paraffin. Although his bodily powers were much enfeebled, he continued his scientific researches up to the last.

GENERAL NOTES.

The Electric Light at the Liverpool Docks.—It was resolved at a recent meeting of the Mersey Docks and Harbour Board, that the electric light should be adopted at a portion of the new dock system at the north end of the city, the estimated cost being £2,000. This is to be an experiment, and upon the result will depend the extension of the light over the docks generally.

Society of Telegraph Engineers.—The library of the Society (which includes the Ronalds Library) is now open daily, between the hours of 11 a.m. and 8 p.m., except on Thursdays and Saturdays, when it closes at 2 p.m. The privilege of using the library is extended to members of all scientific bodies, and to the public generally, on application to the Librarian, at the Society's house, 4, Broad Sanctuary, Westminster.

International Woollen Exhibition.—At the request of several foreign States, the time for receiving applications for space at this Exhibition, which will be held this year at the Crystal Palace, has been extended to the 1st April. The Government of New Zealand has asked for 1,500 square feet of space, and articles that have been shown at the Sydney and Melbourne Exhibitions will be sent from New South Wales and Victoria. The applications to exhibit machinery in motion are stated to be so numerous that it is expected that a large portion of the main floor of the building will be assigned for this purpose.

International Exhibition of Hygiene.—At a meeting of the Committee of the Parkes Museum of Hygiene, it was resolved "That her Majesty's Commissioners of 1851, having expressed to the committee of the Parkes Museum of Hygiene their willingness to provide space at South Kensington for an Exhibition of Sanitary Appliances and the Industries Connected with Medicine on the occasion of the Industrial Medical Congress in 1881, it is desirable that the committee should organise such an Exhibition, provided that a sufficient guarantee fund be obtained." Those desirous of assisting the committee are requested to send their names to the treasurer of the Museum, Professor Berkeley Hill.

Moscow Industrial Art Exhibition.—The fifteenth Exhibition of manufactures and artistic productions of the Russian Empire will be held at Moscow from the 15th May to the 15th September, 1881. The articles exhibited will be divided into 83 classes, arranged under 11 groups. Group 1.—*Works of Art* will consist of oil paintings, sculpture, architecture, engravings, art metal work, and water colours. Group 2.—*Scientific Educational Subjects*, including musical instruments, typography, lithography, photography, &c. Group 3.—*Agricultural Productions.* Group 4.—*Mining Productions and Salt Industry.* Group 5.—*Manufactures from Fibrous Substances.* Group 6.—*Manufactures from Metal.* Group 7.—*Productions Manufactured at Works*, as sugar, starch, tobacco, candles, soap, oils, leather, india-rubber, paper, glass, chemicals, &c. Group 8.—*Industrial Manufactures*, bookbinding, upholstery, clothing, &c. Group 9.—*Machines, Apparatus, Materials of Construction, and Workmanship.* Group 10.—*Horticulture and Gardening.* Group 11.—*Domestic Animals.*

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

January 12.—"A Sanitary Protection Association for London." By W. Fleeming Jenkin, F.R.S. On this evening Professor Huxley, LL.D., F.R.S., will preside.

January 19.—"Causes of Success and Failure in Modern Gold Mining." By A. G. Lock.

January 26.—"Five Years' Experience of the Working of the Trade Marks' Registration Act." By Edmund Johnson.

February 2.—"Trade Prospects." By Stephen Bourne.

February 9.—"The Present Condition of the Art of Wood-carving in England." By J. Hungerford Pollen.

February 16.—"The Participation of Labour in the Profits of Enterprise." By Sedley Taylor, M.A., late Fellow of Trinity College, Cambridge.

February 23.—"Recent Advances in Electric Lighting." By W. H. Preece, Pres. Soc. Tel. Eng.

March 2.—"Flashing Signals for Lighthouses." By Sir William Thomson, LL.D., F.R.S.

March 9.—"Improvements in the Treatment of Esparto for the Manufacture of Paper." By William Arnot, F.C.S.

March 16.—"The Manufacture of Aërated Waters." By T. P. Bruce Warren.

Dates not yet fixed:—

"Buying and Selling: its Nature and its Tools." By Prof. Bonamy Price. On this evening Lord Alfred S. Churchill will preside.

"The Discrimination and Artistic Use of Precious Stones." By Prof. A. H. Church, F.C.S.

"The Compound Air Engine." By Col. F. Beaumont, R.E.

"The Increasing Danger to Life and Property from Explosions." By Cornelius Walford.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

February 1.—"The Industrial Products of South Africa." By the Right Honourable Sir Henry Bartle Frere, Bart., G.C.B., G.C.S.I., D.C.L., LL.D., F.R.G.S., &c.

February 15.—"The Languages of South Africa." By Robert N. Cust.

March 15.—"The Loo Choo Islands." By Consul John A. Gubbins.

April 5.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

January 27.—"A New Mechanical Furnace, and a Continuous System of Manufacturing Sulphate of Soda." By James Mactear. J. C. Stevenson, M.P., will preside.

February 24.—"Deep Sea Investigation, and the Apparatus used in it." By J. G. Buchanan, F.R.S.E., F.C.S.

March 24.—"The Future Development of Electrical Appliances." By Prof. John Perry.

Indian Section.

Friday evenings, at eight o'clock:—

January 21.—"Forest Conservancy in India." By Sir Richard Temple, Bart., G.C.S.I.

February 11.—"The Gold Fields of India." By Hyde Clarke.

March 4.—"The Results of British Rule in India." By J. M. Maclean.

March 25.—"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Second Course will be on "Watchmaking," by Edward Rigg, M.A. Three Lectures.

February 7, 14, 21.

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

March 7, 14, 21, 28.

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Three Lectures.

April 25; May 2, 9.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

May 16, 23, 30.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 10...Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Resumed Discussion on Mr. Watney's paper, "The Land Question in 1880."
Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. F. Harrison, "The French Revolution and the Various Histories of it."

Tuesday, Jan. 11...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Inaugural Address by the President, Mr. Abernethy, and Monthly Ballot for Members.
Photographic, 5a, Pall-mall East, S.W., 8 p.m. Mr. E. Viles, "The Optical Lantern."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.

Wednesday, Jan. 12...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Prof Fleeming Jenkins, "A Sanitary Protection Association for London."
Graphic, University College, W.C., 8 p.m.
Microscopical, King's College, W.C., 8 p.m. 1. Prof. P. Martin Duncan, "Three Microspongiadæ belonging to the Hexactinellids from the Deep Sea." 2. Mr. G. Shadbolt, "The Aperture Question." 3. Prof. E. Abbe, "The True Conditions of Stereoscopic and Pseudoscopic Effect in Microscopical Vision." 4. Mr. A. D. Michael, "A Species of Acarus believed to be Unrecorded."
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

Thursday, Jan. 13...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. Henry Blockburn, "The Art of Popular Illustration."
Inventors' Institute, 4, St. Martin's place, W.C., 8 p.m.
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Mr. A. J. Ellis, "An Apparently Paradoxical Relation of the Circle, Parabola, and Hyperbola." 2. Rev. T. R. Terry, "A Proof of the Differential Equation which is satisfied by the Hypergeometric System." 3. Mr. W. R. Westropp Roberts, "The Periodicity of Hyper-Elliptic Integrals of the First-class." 4. Mr. R. A. Roberts, "The Tangents drawn from a Point to a Nodal Cubic."

Friday, Jan. 14...Astronomical, Burlington-house, W., 8 p.m.
Philological, University College, W.C., 8 p.m.
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m. Annual Meeting.

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FRIDAY, JANUARY 14, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

MUSICAL EXAMINATIONS.

The Society of Arts' practical examination in vocal and instrumental music was held, as announced, on Monday and Tuesday, January 10th and 11th, by John Hullah, LL.D., assisted by W. Barrett, Mus. Bac. Seventy-two candidates were examined. Dr. Hullah has promised a report, which will appear shortly.

The next practical examination will be held during the week commencing 11th July, 1881. Information as to these examinations can be obtained from the Secretary.

SIXTH ORDINARY MEETING.

Wednesday, January 12th, 1881; Professor THOMAS H. HUXLEY, LL.D., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Ameuney, Antonius, 87, Seymour-street, Hyde-pk., W.
Ball, John Ball, F.R.G.S., Carisbrooke-lodge, St. John's-road East, Putney.
Carpmael, Edward, Streatham-hill.
Clark, Mateo, 88, Richmond-road, Bayswater, W.
Crowther, Richard William, 18, Cockspur-street, S.W.
De Villiers, Peter, M.D., Ellora-villa, Silverhill, St. Leonards-on-Sea.
Fell, John Barraclough, The Warren, Torrington, Devon.
Folkard, Henry Tennyson, Wigan.
Gostling, William Kennedy, 8, Gloucester-square, Hyde-park, W.
Herring, John Barnwell, The Grove, Esher, Surrey.
Hill, Robert Martin, 117, Leadenhall-street, E.C.
Klein, Adolphe Louis, Burton-in-Lonsdale, Yorkshire.
Robinson, Robert Alleyne, South-lodge, Cockermouth, Cumberland.
Sawyer, William Phillips, Drapers'-hall, Throgmorton-street, E.C.
Smee, Arthur R., Penrhyn-lodge, Woodberry-down, N.
Standfield, John, 6, Westminster-chambers, S.W., and 44, Lillieshall-road, Clapham, S.W.
Surtees, Colonel Charles F., Chalcott-house, Long Ditton, Surrey.
Tapson, John, M.D., 12, St. German's-place, Blackheath.
Theobald, John Peter, The Chestnut-grove, Kingston-on-Thames.
Thompson, John, Mayor of Peterborough.
Timmis, Illius Augustus, 17, Parliament-street, S.W.
Waterlow, Herbert Jamesson, 1, The Avenue, Brondesbury, N.W.
Wiggins, Rev. William, Spring-vale, Tonge, Middleton, Lancashire.
Wilson, Rev. Charles Thomas, Chapmore-end, Ware.
Wood, James, 26, Cross-street, Ryde, Isle of Wight.
Wright, E. G., 330, Commercial-road, Landport.

The following candidates were balloted for, and duly elected members of the Society:—

Aird, David Alfred, 2, Sussex-gardens, Hyde-park, W.
Angus, Joseph, The Hermitage, Langley-lane, South Lambeth, S.W.
Clements, Hugh, 5, Park-terrace, Peckham, S.E.
Foster, Thos. Nelson, Allt Dinas, Bayshill, Cheltenham.
Morton, Joseph, 39, Cheapside, E.C.
Obach, Dr. E., 17, Charlton-villas, Church-lane, Old Charlton, S.E.
Riddiford, George Francis, Barnwood-lodge, Glouceste
Ridpath, J. Lionel, 12, West Kensington-gardens, W.
Snelgrove, Horatio Richard, The Grove, Clapham-common, S.W.
Sykes, Fred. W., Gosport Mills, Huddersfield.
Traill, James Christie (of Rattar, N.B.), Castlehill, Thurso, Caithness.
Vogel, Sir Julius, K.C.M.G., 135, Cromwell-road, South Kensington, S.W.
Ward, Frederick Peterson, 46, Hamilton-terrace, St. John's-wood, N.W.
Wright, John Brooks, 96, Buchanan-street, Glasgow.
Young, Charles E., 71, Clapham-road, S.W.
Young, Sir Charles Lawrence, Bart., 5, Ashburn-place, Cromwell-road, S.W.
Young, George, 7, The Terrace, Ryde, Isle of Wight, and 43, Dover-street, Piccadilly, W.

The paper read was on—

A SANITARY PROTECTION ASSOCIATION FOR LONDON.

By Prof. Fleeming Jenkin, F.R.S.

Many present may, in the first place, be inclined to ask the question, What is a Sanitary Protection Association? A short account of how the first association of this kind came into existence may, perhaps, convey a clearer idea of the objects aimed at than any mere enumeration of those objects, such as might be given in a prospectus. In the winter of 1877-78, the writer was asked to deliver two lectures on Sanitation before the Philosophical Institution in Edinburgh, and he gladly accepted the duty, believing that there would be no great difficulty in giving simple explanations on the subject, and in laying down rules so simple that each householder might easily apply those rules to his own case, and so render himself secure against the chief dangers arising from bad drainage, bad water supply, and bad ventilation. There is, practically, no serious difference among experts as to the principles to be observed, or, perhaps, it might be more correctly said that there exists a practical agreement as to the main principles and chief points of practice, and that the differences as to practice relate only to minor details. Undoubtedly, a warm discussion often arises, even now, as to the relative merits of various forms of sanitary apparatus, but this discussion is often hottest when the several forms are all good; and an impartial hearer might observe that all speeches appealed to common, well-proved principles, by which the several appliances were judged. The writer holds the opinion that, while niceties of construction cannot be too warmly debated among manufacturers and engineers, they are, nevertheless, of small importance in comparison with a few very simple conditions, the observance of which

will practically ensure that a house is in good sanitary order. Very briefly, these main conditions may be stated as follows:—

1. The liquid refuse from the house must have a free passage to the town sewer.

2. The air from the town sewer must not have a free passage into the house drains.

3. No air or gas from the drainage channels of the house must enter the house.

4. No water or liquids must leak from those channels into the ground under the house.

5. The drinking water must be supplied and stored in such a manner as to run no risk of contamination.

6. The air of the dwelling rooms must be supplied from without uncontaminated.

These points could easily be made clear to an audience, but then came the difficulty of explaining how the various pipes and traps throughout the house ought to be arranged, with a view to securing these conditions; then it was further necessary to explain the modes of practically testing whether pipes were open that should be open, passages closed which should be closed; whether the various channels, with their joints, were so made as to be and remain gas-tight and water-tight. By the time these details, with the necessary diagrams and experiments had been arranged for the lecture, the matter no longer appeared thoroughly simple; indeed, the diagram showing the pipes of a very small house, although made purposely simple for the purpose of explanation, presented an appearance so complex that, after the lecture had been given, one of the audience was heard to remark jocularly, that he had not room in his whole house for such a number of pipes as that. The anecdote tells against the lecturer, for it shows that he had utterly failed to explain his meaning to his hearers; but it also serves to illustrate an undoubted fact, that most householders are quite unaware of the great number and complexity of the channels which penetrate their houses, and yet each one of those channels may become a source of danger.

By the time that the preparations for the lecture were complete, the writer had arrived at the discouraging conclusion that its delivery would be practically useless—that it would add little or nothing to the knowledge of experts, and that the ordinary householder could not be expected so completely to master the subject as might warrant him in trusting to his own judgment when applying the principles. What conclusion, then, was to be drawn? Apparently, only the very lame one, that each occupier ought to call in professional advice, to see, in the first instance, that proper arrangements had been made, and from time to time to inspect whether they continued in working order. But what advice could the public obtain? The plumber and builder were interested parties, and in many cases were insufficiently educated to give sound advice. The engineer, if consulted, must be a man of standing, and would charge a fee such as would be prohibitory in the case of houses belonging to persons of moderate means. The public authorities were in Edinburgh, the Medical Officer of Health and Burgh Engineer. These might be consulted in any case where a nuisance was detected, or even suspected; but it formed no part of their duty to give detailed professional reports as to the arrangement and condition of private houses, in which there was no special reason to suppose that serious defects existed. These officials would have had good reason to complain if the writer had induced 500 or 1,000 householders at once to apply for plans and diagrams of their drainage and water supply, accompanied by detailed reports and specifications of changes necessary or desirable, and to be followed by a subsequent periodical and practical inspection of these works. It was, moreover, obvious that the householders would not be induced to make this application. The lecturer, then, was in the position of having to tell his hearers that the water-carriage system, as it is called, had introduced into their houses a very serious danger; that the complexity of pipes and traps was such that this danger could not be guarded against without professional advice and continual inspection, and yet that no practical means existed, by which men of moderate means could obtain trustworthy professional advice. This conclusion was so unsatisfactory, that he was led to consider whether no plan could be devised for giving sound professional advice and inspection in return for small fees. The idea then occurred to him that the principle first applied by the late Sir William Fairbairn to the inspection of steam boilers, was also applicable to the inspection of houses. An association might be formed, which should employ an engineer or engineers of their own. Each engineer so employed, could inspect and report on a large number of houses annually, and if employed exclusively on this work, he would rapidly acquire great skill and experience. The writer knew that large numbers of well educated young men, who passed through his class in the University and through their practical apprenticeship, would be glad to give their time for about £150 per annum. If these men were to inspect houses and report upon them under the eye of a consulting engineer of standing, the householder would have a guarantee that the principles on which the reports were drawn up, and the inspections made, were such as commanded the assent of the heads of the profession, and, nevertheless, the fee of the consulting engineer who gave this guarantee need not be more, for, say, 100 houses, than he would have to charge for a single house if he were called in for that one special case.

An estimate showed that, including the payment of a secretary, rent for offices, and sundry minor expenses, the proposed benefits could be given in Edinburgh for a subscription of £1 1s. per annum, an estimate which has since been justified by an experience of three years.

The idea was explained privately to a few friends, and met with so much favour that draft rules were passed, and the following circular issued:—

Sanitary Protection Association.

Edinburgh, 21st January, 1878.

Sir,—I have the honour to enclose for your consideration the draft of a prospectus of this association, which is in course of being formed. Your special attention is requested to the following points:—

1. The association is a society for the benefit of its members and the community, and cannot, under its articles, be used for any purposes of profit.

2. The privileges of members include the annual in-

spection of their premises, as well as a preliminary report on their condition, accompanied by an estimate of the cost of any alterations recommended.

3. Even when drains and other sanitary appliances have been put in thorough order, it is impossible to secure that they shall remain in that state without the skilled inspection, from time to time, which it is one main object of the association to provide.

4. No obligation will rest on members to carry out the recommendations made by officers of the association, whose one duty will be to give skilled advice when this is desired by the members.

5. The officers of the association will have no interest in recommending any outlay.

6. The association may (under Rule 5) be of great service to the poorer members of the community.

The following gentlemen have approved of the rules of the association, and consented to act as a provisional committee of management until 500 names shall have been enrolled. Upon this the first general meeting will be held, and a permanent council appointed :—

Provisional Committee.—The Right Hon. the Earl of Rosebery ; the Right Hon. Lord Moncreiff, of Tulliebole, Lord Justice-Clerk ; the Right Hon. the Lord Advocate, M.P. ; Sir Robert Christison, Bart., D.C.L. ; the Hon. Lord Shand ; the Hon. Lord Craighill ; the Hon. Lord Rutherfurd Clark, LL.D. ; James Cowan, M.P. ; the President Royal College of Physicians ; the President Royal College of Surgeons ; the Right Rev. Bishop Cotterill, D.D., &c.

Should you approve of the object of the association, and wish to become a member, you are requested to sign the enclosed form, and send it to the temporary office, 35, North Frederick-street, addressed to the Interim Secretary, Captain Charles Douglas [of No. 2, Rutland-square]. I have the honour to be,

Your most obedient servant,

FLEEMING JENKIN.

The rules of the association were revised by the provisonal committee, consisting of leading citizens in Edinburgh, and the writer was able, at his lecture before the Philosophical Institution, just three years ago, to announce that the association for Edinburgh was constituted. Since that time, and under those rules, the association has worked with perfect smoothness and success. It has given satisfaction to its members ; it has paid its way ; it has spread widely through Scotland, and its action has in no instance given rise to any challenge or ill-feeling. Under these circumstances, the Council of the Society of Arts accepted the present paper, by which the announcement is made that a similar association is now founded in London.

The rules of the London Association are appended. They differ little from those of the Edinburgh Association, and such differences as exist have been adjusted by the London Council. The following abstract will probably be sufficient to explain what the association undertakes to do. The objects are defined as follows :—

1. To provide members, at moderate cost, with such advice and supervision as shall ensure the proper sanitary condition of their own dwellings.

2. To enable members to procure practical advice, on moderate terms, as to the best means of remedying defects in houses of the poorer class in which they are interested.

The entrance fee, which entitles to all privileges of membership for twelve months, is £2 2s. for houses situated within five miles of Charing-cross and rated below £400 per annum. The subsequent annual subscription for the same houses will be £1 1s. Special rates for larger houses can be ascertained from the Secretary.

The following are the privileges of the members :—

1. A report by the engineer of the association on the sanitary condition of one dwelling, with a sketch diagram of pipes, and specific recommendations, if necessary, as to the improvement of drainage, water supply, and ventilation.

2. The inspection of any alterations in the sanitary fittings which may be carried out by the advice, or with the approval, of the officers of the association.

3. An annual inspection of premises by the engineer, with a report as to their sanitary condition.

4. Occasional supplementary inspection and advice concerning the dwelling or property in respect of which he is a subscriber, whenever this advice may be desired. The fee for such occasional advice will be fixed from time to time by the Council.

5. Reports by the officers of the association as to the sanitary condition of any dwellings or properties designated by any member, or on any plans for proposed buildings, on payment of a fee to be fixed by the Council from time to time, with special relation to the rent, or estimated rent, of the premises.

6. A vote in the election of the council, who manage the affairs of the association.

Any member is free to leave the association at any time ; non-payment of the annual subscription will suffice to cause the removal of his name from the roll. The association has no share capital and no profits. The Board of Trade have signified their willingness to license the Edinburgh Association as one of public utility under the Act of 1867, Victoria 30—31, c. 131, and the Board will, no doubt, be prepared to grant an equal privilege to the London Association.

The Council of the association will, by its articles, be unpaid ; the officers have no interest in any outlay or patent.

The first council will be constituted as follows : —President—Prof. T. H. Huxley, LL.D., F.R.S., &c. Ordinary Councillors—J. S. Bristowe, M.D., President of the Society of Medical Officers of Health ; Sir Wm. Gull, Bart., M.D., D.C.L. ; Rev. Harry Jones, rector of St. George's-in-the-East ; Hugh Leonard, late Engineer-in-Chief, Bengal Presidency ; F. Clifford de Lousada, retired commander R.N. ; Sir W. Tyrone Power, K.C.B. ; E. C. Robins, F.R.I.B.A. ; Professor J. S. Burdon Sanderson, M.D., LL.D., F.R.S. ; Professor Alex. W. Williamson, F.R.S., &c. Honorary Standing Counsel—Alfred Wills, Q.C. Honorary Treasurer—T. Holmes, M.A. Cantab., Surgeon and Lecturer on Surgery to St. George's Hospital.

The following will be the first paid officers of this association, holding office at the will and pleasure of the Council:—Consulting Engineers —Fleeming Jenkin, F.R.S., M.I.C.E., Professor of Engineering in the University of Edinburgh and Consulting Engineer to the Edinburgh Sanitary Potection Association ; and H. C. Forde, M.I.C.E. Resident Engineer—W. K. Burton. Secretary— Cosmo Innes, M.I.C.E., 6, John-street, Adelphi.

A short account will now be given of the

manner in which the system is practically worked. A householder or tenant who thinks of joining the association will write to the secretary, Mr. Cosmo Innes, at 6, John-street, Adelphi. In his letter he will state the nature of the premises in respect of which he wishes to subscribe. He will mention the rateable value or actual rent, and the situation of the house. If the situation be within five miles of Charing-cross, and the rateable value of the house under £400, he will know that the terms of the subscription are £2 2s. for the first year, and £1 1s. for each subsequent year. He may either ask the secretary for further information, or he may at once signify his intention of joining the association as a member, and enclose a cheque for £2 2s. He may, if he pleases, call and obtain verbal information from the secretary. When a member joins he incurs no liability, except for the first two guineas. He may or may not pay any subsequent annual subscription; but it is hoped that most of the members who join will remain members of the association, since otherwise they will not receive the full benefit of the scheme. As soon after the member has joined as circumstances allow, the secretary will write to the member, and inquire when it will be most convenient to him to have his house inspected. When the inspection is arranged, the member will be asked to let his plumber meet the inspecting engineer, and also to have the ground opened up in such a manner as to expose the main drain of the house at some point between the house and the town sewer. If the extra expense which this entails is objected to, the inspection cannot be thorough, but may still be useful. The sums paid for opening up the ground do not pass through the hands of the association. Unless some grave defect is discovered in the drain under the house, the opening up of the drain, being done outside the house, need cause no inconvenience to the inmates. The engineer inspects the condition of the main drain, and, assisted by the plumber, takes notes of every pipe, trap, and sanitary convenience in the house; he makes inquiries as to smells and ventilation; he examines all cisterns and arrangements for water supply. When this is practicable, he tests the condition of the pipes by pouring paraffin, or some other volatile strong smelling substance, into the drainage system from the roof. If the smell can anywhere be detected inside the house, a flaw is thereby indicated; this is then laid bare. As soon after the inspection as may be, the member receives a detailed report, describing the condition of his house, accompanied by a sketch diagram showing every pipe and trap; recommendations for improvements are made when necessary, as is usually the case, and some rough estimate can be given of the probable cost of those improvements when this is desired. The improvements recommended are those only which are shown by every-day experience to be necessary. The wishes of the occupier are taken into account, and the more important are distinguished from the less important alterations. The recommendations made are sufficiently specific to enable the member to obtain an estimate from his plumber or builder of the cost of carrying them out. The cost is often considerable, but the member may feel assured that the association has no interest whatever in recommending any expenditure.

The interest of its officers is in the other direction. The less that is done to a house, the less trouble they will have. The less that is done the more popular the association will be. It is, however, only fair to state, that, in the great majority of cases, subscription to the association leads to an outlay in the first year largely in excess of the annual payment. This outlay does not pass through the hands of the association. If the member decides to carry out the recommendations made, or any of them, and gives the secretary notice of his intention, arrangements will be made to inspect the work when completed, or nearly completed. This inspection of the plumbing and other work is one of the most valuable privileges which the member obtains by joining the association. When the alterations have been satisfactorily completed, the member can, on application, obtain a certificate as to the sanitary condition of his premises. This certificate will be of great value to hotels, lodging-houses, and schools. The recommendations made to members invariably include such arrangements as will preclude the necessity for ever again incurring expense in opening up the drain for inspection.

At this point the writer feels that probably all present believe more has been promised than can possibly be performed for the money. This feeling will not be least strong among those best qualified to give an opinion. The writer can, however, speak with the authority of complete experience. It has been shown that these services can be rendered in a thorough and efficient manner, by one resident engineer, for 450 houses or even 500, in one year. The reports, sketch diagrams, and letters in Edinburgh are open to the inspection of all whom it may concern. During three years there has not been one case of complaint that the houses were not thoroughly examined, or that the reports were not sufficiently detailed. At the annual meeting, member after member has risen to express his sense of the thoroughness of the work, and Scotsmen are not easily deluded or even satisfied on this point. At the outset the writer could only plead his own conviction that the work could be done. He is now able to say that, in 1200 cases, it has been done.

The second inspection is a much simpler matter; when the guinea for the second year has been paid, the resident engineer visits the premises, assures himself, by ocular inspection, that there is a free outfall of sewage; paraffin or its equivalent is again poured into the drainage system, and a thorough search made for dry traps, broken joints, or worn-out lead. If the pipe under the house has been laid afresh, in accordance with the association's specification, it can, if necessary, be tested, to ascertain whether it remains water-tight. Inquiries are made as to any alterations which may have been made since the last visit. The condition of the cisterns is examined. The member then receives a second report, in accordance with the facts of the case. This practical and experimental inspection is repeated year after year; it entails no cost beyond the guinea, and no inconvenience. It renders the member practically secure that no imperfection in the drainage system can remain long undetected. More frequent inspections could be arranged for at cheap rates, in special cases, such as schools, where injuries are more likely to occur. The association, therefore, does

not appeal only, or even mainly, to those who have reason to believe that there are grave defects in their houses. Its chief business begins when the house is in good order. The householder is then in a position analogous to that of a manufacturer who has bought a good steam boiler; he knows that the apparatus is good, but liable to decay and derangement; he employs the principle of co-operation to obtain skilled supervision to protect him from the consequences of that decay or derangement. A less measure of inspection than is offered will not protect a house from the dangers inseparable from the system of water carriage for sewage.

There are other minor functions which the association will fulfil.

It will examine plans of projected buildings for architects and builders. This provision is taken advantage of to a considerable extent in Edinburgh.

The association will also examine houses for persons who propose to take them on lease, or for landlords who propose to let houses.

If a member desires a report on the condition of some other premises than his own, such as lodgings occupied by the poor, a report will be made at moderate rates, as a matter of special arrangement. All these reports are strictly private and confidential.

It will be seen clearly that the association does nothing which might not be undertaken by a single independent engineer; where householders already employ an engineer in a similar capacity, and are satisfied with his work, they will gain nothing by joining the association. To the public in general, the Council of the association, by the knowledge and position of its members, affords a guarantee that the officers by whom the advice is given, and the inspection made, shall be skilled and honourable persons. Moreover, it is the duty of the consulting engineer to make sure that the principles on which advice is given are sound, and also to watch that the resident engineers carry out their duties in a zealous and thorough manner. The secretary, also, can aid in watching over the resident engineers, and in our present association he will be specially qualified to do this, for Mr. Innes is himself a member of the Institution of Civil Engineers, and has had large experience of civil engineers' work. The writer will gladly answer any questions as to points which may not, so far, have been made clear to the meeting.

Before concluding, it may be well to answer by anticipation some of the objections which were made to the association when it was first proposed in the North, and which might possibly be repeated here. Some people refused to give it any countenance, on the ground that they did not believe anyone knew anything about sanitation. There is no answer to this objection. Then came the assertion that if any one knew anything about these subjects it was the family plumber. It may be admitted with satisfaction that some plumbers now really have the knowledge which qualifies them to give advice to their clients. It is to be expected that this will more and more come to be the case; but the association will meet the wants of those persons who have not complete confidence in the plumber; indeed, even if all plumbers were thoroughly educated, and thoroughly trustworthy, it would still be desirable that, like all other contractors, they should do their work under professional inspection. Even the late Thomas Brassey—and no name could be mentioned which commands greater respect—was in the habit of saying that it was better he, as contractor, should work under inspection. The interests of the tradesman are not those of his employer; the employer himself has not the technical knowledge which would enable him to control the plumber. The association steps in, and gives the necessary professional assistance. Here it may be remarked that at first the plumbers and builders in Edinburgh viewed the association with some suspicion, and in certain cases with dislike. These feelings have entirely disappeared. It was found that the association led to the execution of more work than would have been done without its suggestions, and that the impartial inspection of its officers was a positive benefit to those tradesmen who did good work.

To continue the list of objectors; a considerable number of persons admitted that the work was both necessary and possible, but asserted that the means provided for carrying it out were inadequate. The inspection would not be real or thorough; and that a sham inspection was actually worse than none. This last proposition must be granted at once. Fortunately, experience has shown that the fears expressed were groundless. If testimonials were wanted from members, they could be had by hundreds. As another proof, the very list of clients might be annexed; these include several of the leading engineers in Edinburgh, Messrs. E. Blyth, B. Blyth, H. Blyth, G. Cunningham Leslie, T. Stevenson, the Royal Bank, the Union Bank, British Linen Bank, the Incurable Hospital, Chalmers Hospital, the Sick Children's Hospital, the Maternity Hospitals, the School Boards, and many other public bodies. The writer is certain that no person acquainted with Edinburgh will state that the inspections, as now conducted, are shams. Perhaps the fear was grounded on a complete misconception. The association makes no pretence at putting badly-drained houses into good sanitary condition for one or two guineas. The improvements must invariably cost a considerable sum—twenty, forty, fifty, even a hundred guineas; in some cases, twice that amount.

The next class of objectors said the association would do too little—that it should not merely give advice, and inspect plumbers, but should itself do the work. It is not denied that an opening exists for plumbing establishments in which the principle of co-operation might be taken advantage of; but this is not, and cannot be, a branch of the present association. To execute plumbing and building, capital is required. If it undertook work, the association would become an ordinary trading company, with the risks and profits incidental to trade. It would no longer be an association of public utility, giving disinterested advice, but simply one more shop competing with other shops.

The next opponent admitted that the objects aimed at were of great importance—of such importance, indeed, that, in his opinion, they ought to be carried out by public authority, and not by a mere private association. So far the writer agrees

with what was said, but the conclusion is surely false, that we ought not to do anything for ourselves which Government might possibly do for us. A considerable number of persons declined to join the association because they thought it weakened the claim of the community to have that done by compulsion and taxation which the association carried out by the voluntary principle. The writer respects the heroism of those who die as martyrs and let their children die, in unhealthy houses, rather than have these made healthy by a means which they deem impolitic—but he thinks their reasoning unsound.

In this country, custom precedes law, and no better laws are made than those which recognise and extend good customs. If we can show that, at small expense, a thorough inspection can be carried out in the houses of the well-to-do, that this inspection is needed, welcome, and effectual, we shall greatly strengthen the hands of those who would extend that inspection down to the poorest level in the town, an object in which they have the heartiest sympathy of the writer. This association is probably only one step towards a general compulsory inspection. When this is established, the association may either cease to exist as no longer needed, or continue to exist, as supplying a better and fuller inspection than that provided by law. Meanwhile, no one need hesitate to join, from any fear that, by so doing, they would weaken the case of those who would forward improved sanitary legal measures.

Next in our list of opponents came those who said the law already provided all that was required—that, in Edinburgh, the medical officer of health and burgh engineer, and, in London, the medical officer of health, the inspector of nuisances, the local surveyor, and the surveyor appointed by the Metropolitan Board of Works already gave, or could give, gratis all that the association promised to give for a guinea. It is quite certain that the ratepayers have privileges of which they are largely ignorant, and of which they very seldom avail themselves. It is also certain that, in most cases, these public officials are obliging and zealous in giving their services when asked to do so; but it is equally certain that neither in Edinburgh nor in London is such a systematic inspection as the association offers carried out by law. If the public could and did insist upon such an inspection, the public staff would have to be increased ten or twenty fold. The writer will not be so bold as to give the smallest opinion as to what the rights of the ratepayer may be under the Metropolitan Local Management Acts, but it is notorious that the inspection which the association offers does not at present exist.

Next in the list of antagonists came those who looked on the association as a body inflicting a slur of some kind on the public authorities, or as established to supply some defect in their action—even as a disgrace to the town itself; for they urged, if the town had good sewers, your association would be of no use. Perhaps the best answer to those who agree with these gentlemen is, that the chief public sanitary authority, the convener of the Public Health Committee, is himself on our council in Edinburgh, and that the President of the Society of Medical Officers of Health is on the council of our society in London. Our work does not clash with that of the public authorities; we begin where they leave off; inside houses which, unless some nuisance is reported, they have, probably, no power to enter. If sewers were all as perfect as sewers can be, the need of annual inspection would be diminished, but would not be ended. Bad sanitary fittings in a house may render nugatory all attempts to isolate cases of infectious illness occurring there, and this will remain true when every town sewer is perfect.

No one came forward in Edinburgh to say that the association was competing unfairly with professional men as sanitary advisers. This has been said in London, but the grounds of the accusation are not clear. The resident engineer is paid at the rate common for men of his standing. The consulting engineer receives a fee which, having regard to the call on his time, is remunerative.

All these objections experience has shown to be of no value, but there remains one objection which will always be serious. Persons shrink from becoming members because they fear that by enrolling they will be led to expend a considerable sum of money in sanitary improvements. "I do not mind the two guineas," they say, "but I shrink naturally from the fifty guineas which this may entail." The objection is valid, but yet it sounds strange when it is urged by a person who says, "I know my house is in very bad order; it was built long ago; rats abound; smells pervade, and we are much troubled by sore throats." What expenditure of money is justifiable if not that which tends to secure good health? No doubt the hesitation is partly due to a doubt whether the sanitary engineer really knows anything at all about the matter. The association does its best to remove that doubt; the reports explain what is wrong, why it is wrong, and what will put it right. The member is left to his own common sense as a guide whether he will follow the recommendations made. It is a matter of no pecuniary interest to his adviser whether the job is done or not, and that adviser is selected and watched by a council, consisting of men as well qualified for this purpose as can be found in London.

APPENDIX.

The following documents, consisting of the provisional rules of the London Association, and the balance-sheet of the Edinburgh Association, are given here for the information of those who may wish to found associations of the kind in other parts of the kingdom or abroad:—

I.—PROVISIONAL RULES.

OBJECTS OF THE ASSOCIATION.

The objects of this association are twofold:

1. To provide its members, at moderate cost, with such advice and supervision as shall ensure the proper sanitary condition of their own dwellings.

2. To enable members to procure practical advice, on moderate terms, as to the best means of remedying defects in houses of the poorer class in which they are interested.

No obligation will rest on members to carry out the recommendations made to them.

The association is not intended as a substitute for a municipal inspection, and will not conflict with the public authorities, but will supplement their action. Thus it is not proposed that the association should undertake the superintendence of houses while they are being built, or that it should in any way interfere with the public system of sewers.

Admission of Members.

Persons become members on payment of an entrance fee, and continue to be members so long as they pay an annual subscription. The entrance fee and annual subscription are regulated by consideration of the annual value and situation of the dwellings in respect of which they are paid.

For ordinary dwellings within five miles of Charing-cross, and of a rateable value under £400 per annum, the entrance fee and subsequent annual subscription are fixed at £2 2s. and £1 1s. respectively for original members. The entrance fee, which may be paid at any time during the year, entitles the member to all the privileges of the association for twelve months from date of payment. The annual subscription is good for the following twelve months. For all other dwellings than those already named, the entrance fee and annual subscription will be determined by the council.

After the 1st of January, 1882, the council shall have power to increase or decrease the entrance fee and annual subscription for new members, but shall not have power to increase the annual subscription of members who have joined before that date.

Privileges of the Members.

Each member will be entitled to the following privileges:—

1. A report by the engineer of the association on the sanitary condition of one dwelling, with a sketch diagram of pipes, and with specific recommendations, if necessary, as to the improvement of drainage, water supply, and ventilation. This report will be obtainable on his joining the association, or as soon thereafter as may be.

2. The inspection of any alterations in the sanitary fittings, which may be carried out by the advice, or with the approval, of the officers of the association.

3. An annual inspection of his premises by the engineer, with a report as to their sanitary condition.

Note.—No single inspection of any premises will secure permanent efficiency. Methodical inspection from time to time is absolutely necessary as a protection against inevitable decay, neglect, and accidental disturbance. Examples of failure where the design was good and the construction originally faultless are of daily occurrence, and are due to such causes as the gradual stopping of pipes and drains by kitchen grease and rubbish, the corrosion of metal pipes, the fracture of earthenware pipes, or the stopping of ventilation openings by dirt.

4. Occasional supplementary inspection and advice concerning the dwelling in respect of which he is a subscriber, whenever this advice may be desired, on payment of a small supplementary fee on each occasion that an officer of the association is called in. The fee for such occasional advice will be fixed from time to time by the council.

5. Reports by the officers of the association as to the sanitary condition of any dwellings designated by any member, or of any plans for proposed buildings, on payment of a fee to be fixed by the council from time to time, with special relation to the rent of the premises to be inspected.

Note.—Under this rule intending occupiers, architects, and builders will be able to avail themselves of the services of the association. This rule will also enable members to assist the poorer classes of the community. It is to be understood that no premises will be inspected unless the occupiers themselves assent to the inspection.

6. A vote in the election of the council who manage the affairs of the association. If one member subscribes in respect of several dwellings, he shall have a vote in respect of each.

Note.—The association will not publish any reports made to a member. The reports are to be considered confidential, and in using these reports each member must act on his own responsibility.

Meetings.

A meeting of the association will be held annually in February, at which a council of at least ten members will be appointed, four of whom shall at any time be a quorum.

The council shall meet as often as from time to time may be found necessary for the disposal of business, and have power to call extraordinary meetings of the association when they think proper.

Officers of the Association.

President and Council.—The affairs of the association shall be managed by a council, who shall receive no remuneration, and who, with the exception of the first council, shall be elected from time to time by the members of the association from among their own body. The council shall, from their body, elect a president and a vice-president, whose business it shall be to preside over the meetings of council.

The council shall have power, from time to time, to frame bye-laws for the better administration of the association, and to extend its influence, but not to alter the general objects of the association. The council shall have power from time to time to determine the area of operation of the association in such manner as may seem to them best fitted to promote its objects.

The council shall appoint, and shall have power to dismiss, all paid officers of the association. All expenditure of the funds of the association shall require the sanction of the council.

All paid officers shall hold their appointments at the will and pleasure of the council.

The permanent officers shall consist of a consulting engineer or engineers, a resident engineer or engineers, a secretary, and a treasurer. The appointments of secretary and treasurer may be held by one person.

Consulting Engineer.—The consulting engineer shall, on his appointment, declare that he neither has, nor will acquire during the term of his appointment, any interest in any patent or manufacture connnected with sanitary appliances.

He shall give advice to the council and resident engineers, when required to do so, both as to general principles and particular cases presenting any difficulty. He shall, subject to the approval of the council, lay down the general rules, to which the specific recommendation of the resident engineer must in all cases conform. His remuneration shall be fixed from time to time by the council.

Resident Engineer.—Each resident engineer shall, on his appointment, declare that he neither has, nor will have, during the term of his appointment, any interest in any patent or manufacture connected with sanitary appliances. The salary of the engineer will be paid by the association, as may be fixed from time to time by the council.

The resident engineer shall, in all cases, report in writing, and submit his report to the secretary, who, unless he sees reasons to the contrary, will transmit the same to the member interested.

The resident engineer shall not, as an officer of the association, recommend to the members the employment of any builder, plumber, or other tradesman. He shall not recommend to the members the employment of any patented appliances, unless these shall have met with the approval of the council and the consulting engineer.

Secretary.—The secretary shall, on appointment, declare that he neither has, nor, during the term of his appointment, will have, any interest in any patent or manufacture connected with sanitary appliances. His salary shall be fixed by the council.

The secretary shall keep such books and forms as the council shall from time to time direct, and he shall have the superintendence and charge of all the minute books, letter books, lists, and registers, belonging to the association, which registers shall contain a summary of the communications. He shall keep the minute books of all meetings of the association and of the council. He shall also keep a register or list of the titles of all communications which shall have been received, in the order of the dates when these shall have been so received. He shall prepare, and cause to be issued, printed circulars to all the members resident within four miles of Charing-cross, and to all such members, resident in the country, as may express a wish to have circulars sent to them, at least two days before each general, ordinary, or extraordinary meeting, containing the programme of all business to be brought before each meeting. He shall conduct the correspondence of the association in accordance with the rules which may from time to time be laid down by the council. He shall obey the instructions of the treasurer in all matters relating to finance. Copies of the reports and plans shall be submitted by the secretary to the council at each meeting, and shall at all times be open to the inspection of the members of council and the consulting engineers.

Treasurer.—The treasurer, or some person appointed by him, shall receive for the use of the association all sums of

money due or payable to the association; and shall pay and discharge all sums due from or payable by the association; and shall keep particular accounts of all such receipts and payments.

Every sum of money payable on account of the association exceeding £5 shall be paid only by cheque signed by the treasurer and one other member of council.

All sums of money, which there shall not be present occasion for expending or otherwise disposing of, to the use of the association, shall be deposited in a bank, or laid out in such Government or other securities as shall be approved of and directed by the council.

The treasurer shall demand, or cause to be demanded, all arrears of annual payments as they become due.

At each meeting of the council a statement of accounts shall be laid on the table by the treasurer.

The accounts of the treasurer shall be audited annually, a short time preceding the annual general meeting, in such manner as may be directed by the council.

As soon after the audit as may be, and before the annual meeting, the treasurer shall cause an abstract of the association's accounts of the preceding year to be printed for the use of the members.

II.—ACCOUNTS.

Balance-sheet presented at the Second Annual Meeting of the Edinburgh Sanitary Protection Association, March 30th, 1880:—

Charge.

Balance at the Credit of the Association on 18th March, 1879		£29 18 8½
Annual Subscriptions received for the year from 18th March, 1879 to 18th March, 1880—		
412 at £1 1s. each	£432 12 0	
29 at £2 2s. upwards	70 7 0	
Sum,		502 19 0
Interest on Bank Account to 31st December, 1879		1 10 2
Sum of the charge		£534 7 10½

Discharge.

Salaries of Officials—		
To Professor Fleeming Jenkin as Consulting Engineer		£52 10 0
To Mr. Walsh, Resident Engineer—		
One month at £150 per annum	£12 10 0	
Eleven months at £170 per annum	155 16 8	
		168 6 8
To Captain Douglas, as Secretary		100 0 0
Sum		£320 16 8
To Inspectors for assisting Resident Engineer at Inspections		11 14 5
To travelling expenses of Resident Engineer		1 3 9
To Office Rent and Taxes		37 18 10½
To Stationery		6 11 1
To Advertising and Printing		38 16 0
To Furniture and Removing Office		10 9 1
To Collector's Commission at 5 per cent.		6 7 6
To hiring Masonic-hall		1 1 0
To Charwoman for year		11 12 0
To Postage and Sundries		14 8 7
Sum of the Discharge		£460 18 11½
Sum of the Charge		534 7 10½
Balance in favour of the Association		£73 8 11

"Edinburgh, 30th March, 1880.

"I have examined and audited the foregoing account, and I have found it to be properly and sufficiently vouched, and correctly stated, and there is a balance of £4 7s. 6d. due by Captain Douglas, as on the 19th March current. I have prepared an abstract of the accounts, to which I beg to refer, and from which it appears that, in addition to the above balance, there is also a balance due by the bank of £69 1s. 4d.

"Thomas Scott.

"29th March, 1880."

DISCUSSION.

The Chairman, in inviting discussion, said he must indicate as briefly as possible how his name came to be placed in the honoured position which it held, at the head of the association. He felt in that position something like the proverbial "fly in amber," because by any extreme stretch of the term "natural history," the study of which was his proper business, he did not see how sanitary inspection could be included in it. Like all the rest of the world who had any knowledge of physiological matters, or any conception of the laws of life, he had always taken a sort of theoretical interest in questions of sanitation; but there was a wide difference between a theoretical and practical interest, and that was brought home forcibly to his mind some three years ago, when suddenly, without warning, three of his children were struck down by diphtheria, and one of them lay a long time between life and death. This was a lesson which turned his attention more strongly to the importance of this question of sanitation than all the mere talk about it he had ever heard. He became deeply interested in the sanitary condition of his own house, which was exceptionally well situated, and in which, he thought, all reasonable precautions had been taken. It turned out, on a full investigation of the history of that very curious epidemic, that it was not his house which was in fault at all. His children were poisoned through milk, and the most careful inquiry, which was made afterwards by the officers of health, left a keen conviction on his mind —although the evidence did not exactly amount to proof—that the fault certainly did not lie in his house, or in those of a large number of his neighbours, who were many of them much worse dealt with by the epidemic than he was, but that the origin of the whole mischief lay in a preposterous inattention to the conditions necessary to be attended to for properly draining a large and populous district. He took a deal of pains with the question at the time, and resolved that if ever he could serve the cause of sanitation in any way he would do so, and would do anything he could to bring before the mind of the public, with that amount of vividness which was necessary, the fact that unless sanitation was attended to in crowded cities like London, before long they would be devastated by diseases introduced, by their own contriving, into their own houses, on a larger scale, probably, than were the cities of old by plague and pestilences of other kinds. He was glad to be able to do anything to bring that fact before the minds of the people of London, and to get them to do as Professor Jenkin had pointed out—take ordinary means for protecting themselves without looking for extraneous help. It was on this ground that he had consented to join the committee, and he only regretted that the council had thought fit to put him forward as their representative and chairman. He could not do much in that capacity, but he was happy to say that when once the society was in working order, there would not be very much for either chairman or council to do; at any rate, what little had to done, which he could do, should be done to the best of his ability.

Sir Henry Cole, K.C.B., thought every one would agree that if they were to get sanitation in London, they must do the work themselves. He had had some little experience of Vestries, and he saw no salvation in them. He had been before the Metropolitan Board, where he was politely asked if he ever read Acts of Parliament, as there were such extensive powers for doing everything right. He had been to the President of the Local Government Board, and pointed out to him that the street in which the present Prime Minister lived had been found to have half its houses unconnected with the sewer at all, and all he got was a kind word of sympathy. The Society of Arts had been at work on

the matter for the last seven or eight years, in the only way it could, and at last it had actually done something. The present Council having determined to give some additional conveniences to the members, called in an expert to inspect the premises, who told them, as they expected, that their sanitary arrangements were as bad as could be. The Society had acted as a pioneer in this work; it undertook to inform the public, and afterwards to give lessons to members of Parliament; and, to some extent, therefore, they might claim to have helped on Professor Jenkin's scheme. There was, however, more than one Richmond in the field. Going back a little, Mr. Cresswell had brought forward there the idea of a sort of sanitary Lloyd's, in which people might insure; then came the Edinburgh work, and then came the Parkes' Museum of Hygiene; then there was the Sanitary Institute, the National Health Society, and a Ladies' Sanitary Institute. He enumerated these to show what a deal of prodding it required before you could get up enthusiasm enough to carry anything into operation. Earlier than any of these there were Dr. Farr, Mr. Chadwick, and the engineer now present (Mr. Rawlin on), who went to the Crimea to help to make the troops a little healthier than they would have been without him. The Council of the Society had it under consideration to offer three medals to the proprietor or builder who should produce three good houses in London, which should be held up as illustrating the most advanced opinion on correct sanitation. No doubt there would be some difficulty in the matter, but the public mind would be thus directed in the right road. It was no use going to Parliament until they could make it listen, and that would not be until constituents throughout the country insisted on their members paying attention to the question of health.

Mr. R. Rawlinson, C.B., said he most heartily wished God speed to the association now started, which he had no doubt would do a great deal of good. Professor Jenkin had mentioned pipes within houses, traps, and plumbers; but when houses were dealt with as they ought to be, there would be no drain-pipes within them, and plumbers would have very little, if anything, to do with them. It was quite possible so to arrange the largest buildings that there should be no drain-pipe within its external walls, and no need for the intervention of any plumber. The whole of the apparatus might be of iron. With regard to improvements, he would only say that in ancient times the Egyptians called in experts to embalm the bodies of their dead, but when they had performed the operation, they had to escape for their lives; and he feared that the sanitary engineer was looked upon somewhat in the same light. He was called upon to advise, but if he were an honest man, and the premises were in a very bad state, it was absolutely necessary that he should turn them inside out, which necessarily cost a large expenditure of time and money, and caused a great deal of personal inconvenience; and he could assure the meeting that the householder cordially hated that man by the time he had done his work. Before that association or any other existed, he had probably done as much gratuitous work of this kind as anyone, for he never refused to respond to an application for advice on sanitary matters, from any person who came to him with an introduction from a personal friend. But he had occasionally found that persons possessing wealth set so much store by it, and thought so little of their own personal comfort and health, to enable them to enjoy that wealth, that they put away the idea of spending any considerable sum, and suffered the rats, and the stinks, and the rot to go on, and went to their graves as they had begun. There was now a great movement amongst the dry bones of ignorance throughout the world, and a paper of this description, when distributed broadcast, was calculated to do a great deal of good, and he had no doubt the association also would do good. The apathy in this matter more frequently came from the father than from the mother, as he was not within the building perhaps more than five or six hours out of the twenty-four, and they who suffered most from the bad arrangements were the delicate children, ladies, and those who were living on the premises. One after another the children might be seen falling into consumption, and fading away before a father's eyes; but he might be ignorant of what was the cause, and let evil go on day after day. He (Mr. Rawlinson) would tell them that, according to his experience, the cause of ill-health throughout the length and breadth of the civilised world, even in malarious districts, was not so much in the atmosphere, not so much in the earth, not so much in the swamp, as in the habits of the people, and in their foul dwellings. Probably he could speak with as ripe a knowledge as any man. He was a member of the Army Sanitary Commission—a body of which the public knew nothing. The Quartermaster-General of the Army, for the time being, was always the chairman, and it included besides the Second Medical Officer of the British Army, the Royal Engineer quartered in London, the Chief Medical Officer from India, and one of their chief engineering officers. They had returns coming in regularly. Wherever a British soldier was quartered on the face of the earth, they had returns as to the climatic influence and the conditions under which he was living, so that he (Mr. Rawlinson) was justified in drawing the conclusion he had mentioned, that it was not so much the climate as the conditions of life which made the difference. As the meeting was aware, he was one of a Commission sent out to the Crimea, where such a mortality prevailed as had never previously been known. The Russian retreat was not so bad; the Walcheren expedition was not so bad. Some regiments lost 700 men out of 1,000 in three months. The Commission found those hospitals reeking with filth — the men living under the worst possible sanitary conditions. Some persons blamed the military and medical authorities, but they really were not so much to blame, because those wonderful regulations, which were tied up with red tape, prevented anything being done. The Commission to which he belonged went out, however, entirely unfettered; their instructions would be found in Kinglake's last volume, and that author spoke most highly of them. So did the American Sanitary Association, which was founded on the model of theirs. They were not fettered in what they ordered or what they expended, and the result was that, by simply carrying out cleansing operations, in three months they brought the mortality in those hospitals down from about 15 or 16 per cent. to $1\frac{1}{4}$ per cent., and by the end of the summer the entire British army in the Crimea was healthier than ever it had been in barracks at home. At this moment he might say broadly, that whereas previously to 1858, the returns showed that the army had suffered at the rate of $17\frac{1}{2}$ per 1,000, and in India, 69 per 1,000, since improved sanitary regulations had been carried out, the mortality at present was less than 7 per 1,000, and, in India, less than 20. He had not a shadow of doubt that London, wonderfully healthy as it was, might have its mortality considerably reduced, and he would give a case in point. In Leeds, some years ago, he found the sewers were not ventilated, and the rate of mortality was high. Fortunately, they had now an exceptionally intelligent engineer, and he had done what ought to be done generally; he had not only ventilated all the main sewers, but he had untrapped every gully. The result was, there were 20,000 gullies which had no traps, and the combined area was equal to something over 3,300 square feet always open to the atmosphere. By the last returns, the mortality was reduced to about 19·9, whereas last year it was 25·5. If there was one thing more difficult than another, it was to induce people to ventilate the sewers and drains.

There were towns which persistently bottled up their sewers, because if they made one opening, they said it stank so abominably—and so it did—that they shut it up again, instead of opening 20, 50, or 100 others. He had recently reported on Dublin, which had 400 ventilators on their main sewer, whilst he ascertained that to make them safe they ought to have 2,800. This question was at the root of sanitary improvement. Any house having drains within the four walls which had openings into them was not in the condition it ought to be. If a drain must traverse the basement from back to front, as in many cases it must, he would resort to an iron pipe, with a ventilator behind, he would cut it off the main sewer in front, and bring the communications with the sinks and closets into it outside the walls.

Mr. C. N. Cresswell said that every lover of sanitary progress must sympathise with the efforts of Professor Jenkin and Professor Huxley, to promote the real well-being and health of the people; and, of course, those who had been conspicuous in that Society in the promotion of the good cause, rallied to support an excellent effort, however small it might be compared with the magnitude of the evil with which they had to cope. With that view he had come over from Paris to pay his small tribute to the man who had come from the seat of learning in the north to help Londoners in the cause they all had at heart. But he must confess that he was somewhat disappointed by the almost insignificant proportions of the weapon with which it was proposed to deal with the enemy. It was a very thin end of the wedge, and he cordially agreed with the remark of Professor Jenkin that it was probably only one step towards general compulsory inspection. In that sense he welcomed it, and if it tended in any way to serve that cause it was worthy the support of every lover of his country. The very title of the association showed that it must be of very limited operation, and, by the rules, it appeared that it was confined to domestic sanitary protection. Now, sanitation was a very large subject, and went far beyond the limits of the mere household. There were other causes, other evils to which attention had often been called there, which he wished some grand association might be promoted to deal with and repress, and, therefore, he felt that, surrounded as they were by a most unsanitary atmosphere, physical and moral, on this subject, it would have been well if the association had been so formed as to enable it to deal with the difficulty in a far more radical and drastic mode. However, it would be ungracious to pursue that line of argument any further. They ought to be grateful for even the smallest mercies, and to thank those who came forward with their time and scientific reputation to assist. But after all, how little could they do in such a metropolis as this. During the three years the association had been in operation in Edinburgh, admirably organised and well supported, they had succeeded in dealing with 1,200 houses only. In London he believed there were 400,000 or 500,000 houses; they were increasing at the rate of 60,000 to 70,000 per annum, and out of those new houses built every year 50,000 were unfit for human habitation. That showed the evil with which they had to cope. Some allusion had been made to his own efforts; he had the honour in June last of propounding a scheme which should have the sanction and co-operation of every County Board—such as they might have some day—every municipal authority, and every public body which had the right to exercise such powers as would be necessary; he had the support of the Right Hon. Mr. Stansfeld, Dr. Richardson, Dr. Voelcker, authorities recognised everywhere, and the unanimous approbation of a crowded meeting, and what had been the result? It had been absolutely ignored as far as public opinion went; nobody condescended to notice it. Possibly the seed he sowed was bad; possibly it fell on barren ground; possibly it was choked with the weeds of prejudice; possibly it was not watered with what was necessary to growth in anything—a strong popular public opinion; but from one cause or another "unmarried ere it saw the sun." This effort, he it had fallen—died, as Shakespeare said of the primrose, hoped, might have a more prosperous career. They were to have County Boards in Ireland, and, perhaps, when Irish affairs were settled, they might have them in England; and it was through County Boards and great municipal bodies he hoped to see some grander step taken even than this. The first step would be an attempt to supersede the miserable apology for a government called the Metropolitan Board of Works and the Corporation of London. Let them seek to give the metropolis a form of government founded on common sense, and invest the governing body with the power to compel, in the sense of passing laws to enable every householder to obtain that which he demanded, and every municipal right to enforce that which was absolutely essential for the welfare of the public.

Mr. J. I. Tracy advised people not to rely on professional aid, but for each one individually to look after his own interests. He considered that great engineers and surveyors had done an immense deal of mischief in the works they had carried out.

Mr. Rogers Field agreed in the main with Mr. Rawlinson's remarks. The point he felt a difficulty about was the possibility of giving adequate inspection for the terms mentioned. His experience showed that work of this character required a great deal of time, and careful inspection throughout, and unless it were thoroughly well done, harm instead of good must result. He gave an instance where he had been called in, after a case of typhoid fever; but his recommendations were not fully carried out, on account of the expense; and the consequence was that fever again occurred. Eventually the work was thoroughly done, and the house became healthy; but if it had not been so completed, it would have been said, "You called in a surveyor; you spent a great deal of money, and the house is as bad as ever;" and he could not imagine anything more likely to injure sanitary science than such a state of things. Since then he had made it a rule, if his clients would not do what he considered necessary, to have nothing to do with the case.

Mr. E. C. Robins did not sympathise with the remarks of Mr. Field, who did not seem to understand the principle they proposed to act upon. He thought Professor Jenkin had shown that the householder's difficulty was, not that he did not know some of the principles to be observed, but he did not know how to apply them. It was an expensive affair to call in Mr. Field, and there were thousands of people who could not afford it, but were they not to have good advice at all? They were not responsible for people not taking good advice, or stopping in the middle of a job, and saying they would not do any more. They owed a debt of gratitude to Professor Jenkin for showing the practicability of this scheme in Edinburgh, where 1,200 houses had been put into good order under the supervision of the society, who charged no more than the guinea, or two at the outside. That was the thing wanted in London, and the more they had of it the better. There were plenty of practical men here, able to carry out the instructions given to them; there were some honest tradesmen, and it was a false conclusion to come to, to say that nothing effectual could be done unless there were perpetual inspection by highly skilled surveyors. He had had as much experience as most men of bad work, and knew how important it was that there should be that proper participation between master and man, which would make them all feel interested in carrying out the work in the best possible way. He had had personal experience of the usefulness of the Edinburgh Society, for his friend, Professor Fischer, of St. Andrew's, got their engineer down to inspect his house, and had the recommendations carried out by

local workmen; it was afterwards inspected, and any defects set right, and the result was most satisfactory. He did hope, therefore, that the plan would receive all the attention it deserved.

Dr. Waters said this subject was of the greatest importance, and perhaps medical men could speak on that subject more strongly even than engineers. It was not only great diseases which were brought into the house by sanitary defects, but minor affections, such as headaches, sickness, diarrhœa, &c. It seemed to him, however, that the scale of payment was scarcely adapted to London, as well, perhaps, as to Edinburgh. A house of £400 a year, near Charing-cross, would be much smaller than one of the same rent five miles away, and the amount of work to be done would be very different; yet the same fee was charged. He was a director of a similar society, which based the fee charged on the number of water-closets in the house, and this he considered preferable.

Mr. White gave a practical instance of the usefulness of this association. He knew a house which had been in a most unsanitary state ever since it had been built, and he was advising the occupants to give notice that they should not continue in it unless it was put into a sanitary condition, to the satisfaction of the engineer of the association. He had felt strongly for many years the helpless condition in which tenants were placed with regard to these matters; he had again and again endeavoured to get landlords to set matters right, but they had shirked it. It would be brought home to them practically if they received notice that the tenancy would not be continued unless their house were put into a sanitary state. He could not but think that in a few years, the association having shown its usefulness in a small sphere, it would by degrees induce Vestries and Local Boards to take up the question, and establish local associations of the same kind in each district, which would do the work which one body could never do over so large an area as London.

Mr. William Botly wished to say a word in corroboration of the views expressed by Mr. Rawlinson. In his own house he had had all the pipes removed from the inside, and the water-closets also put outside. The original estimate was £25, but improvements were made in the course of the work, which brought it up to £72 eventually; but no money was ever better laid out.

Mr. H. H. Collins, having had 26 years' experience with all kinds of buildings, could only come to the same conclusion as Mr. Rogers Field, that the fee charged was totally inadequate for anything like a proper inspection, even by a skilled workman. That very day he had been inspecting a house of about £150 a year rent, and though the drainage had been laid open on the previous day, it took him from nine in the morning until half-past four in the afternoon in order to get the data to write his report, the writing of which and preparing the plan would occupy him three or four hours more. It was impossible for a professional man of any standing to do that work for anything like the sum named. It was all very well to have theory, and you could not do without it, but in these matters you also required practical and extensive experience, for nearly every house had its own peculiar conditions. No young man would be competent to deal with such matters satisfactorily, and if the name of an eminent engineer were attached to a report which he had not been personally prepared, it might really do more mischief than good in the end.

Prof. Fleeming Jenkin, in reply, said he had endeavoured to avoid anything which could be called sensational in describing the evils under which they laboured, because he knew that every one present there, at any rate, was fully sensible of those evils. With reference to Mr. Rawlinson's remarks, he could only say that the association attempted to deal in the first place with facts as they were; they had to look at houses as they existed, with a good many pipes inside them. If they came forward and told every householder that all these pipes must be taken out, very few people would consult them, and they would not do nearly so much good as they might. There might be a good many healthy houses in which there were some pipes, although he cordially agreed with the principles laid down, that if you were to design a new house, the mode suggested was the proper one. In reply to Mr. Cresswell, he could only say that the association was a modest one; it did not propose to do everything; but only something—and something practical. There was only one point in the description to which he felt it necessary to seriously address himself, and that was the one raised by Mr. Field and Mr. Collins. It was one he had answered to some extent by anticipation, because he expected it. Mr. Collins was present at the meeting of the Social Science Association at Edinburgh, and he (Prof. Jenkin) also came there from abroad for the purpose of discussing this very question. The association had been started in Edinburgh, where he was known and, to some extent, trusted, and the same difficulty was raised at the outset, but a great many people put some confidence in him, and that confidence had not been misplaced—at any rate, no one had made any complaint. He attended the Social Science meeting because he thought a great many engineers would come there and hear what had been done, and they would have the opportunity of challenging the success of the association and the thoroughness of the work. Mr. Collins heard his paper read, and heard several persons speak upon it; he heard the opinions of the medical officers of health, and of Sir Robert Christison in favour of the association, but no one got up to say the work was not thoroughly done. Mr. Collins did not get up then and say what he had said now, or he would have been met with a very different answer. The books were open to him, why did he not go and look at them? How dare anyone who had had an opportunity of consulting these reports come there and tell him in effect that he, a member of the Institution of Civil Engineers, was offering something which was a sham and a delusion? He had some reputation, and he was not going to stake that reputation on anything he could not support. He did not come to London until the thing had been at work three years in Edinburgh—until he could come forward, not only with a hope which justified him in beginning the work, but with a certainty. He could read any number of letters on the subject, but it would be merely self-laudation. He had done enough to justify him in asserting that they could do good work, small as the price might be. If he did not, he was fully alive to the responsibility he should be incurring by giving a sham inspection, and a sham report, which would be good for nothing, if not worse than nothing. All he could say was, give them a trial; if the work was badly done, they would not be tried again; bad work could not possibly live. Let all associations with the same object flourish; let some charge more and some less; let those who could afford to pay fees to engineers of eminence for personal attention continue to do so, but until some case was proved of inattention or of inefficient work done by that or any other association which worked cheaply, engineers should not get up to say the work would be badly done.

The Chairman then proposed a vote of thanks to Professor Jenkin. The statement he had made was so clear and definite, that if it turned out to be correct he would assuredly reap the credit which he deserved; while, if it proved incorrect, it was so definite that there could be no doubt about the matter. They might also thank him for the very vigorous and, at the same time, good-tempered defence he had made of his position.

The resolution was carried unanimously, and the Proceedings terminated.

CANTOR LECTURES.

SOME POINTS OF CONTACT BETWEEN THE SCIENTIFIC AND ARTISTIC ASPECTS OF POTTERY AND PORCELAIN.

By Prof. A. H. Church, M.A. Oxon., F.C.S.

LECTURE IV.—DELIVERED MONDAY, DEC. 13, 1881.

Soft Paste Porcelains, European and Oriental.

Softness, as tested by the file, or by a fragment of quartz (or even felspar), and by fusibility in the kiln, generally go together in the case of translucent wares, usually known as porcelain. No exact classification of these pastes, or bodies (which, after all, are mere mixtures, variously and often capriciously compounded), is possible. But it is not without reason that the glassy, the felspathic, the phosphatic, and the kaolinic constituents which characterise certain wares, should be regarded as determining the species or kind of porcelain to which they severally belong. But difficulties in classification after this fashion are always arising, when one has, for instance, to find a place for such a composition as the soapstone body of early Worcester make, and the glaze-formed porcelain of Persia. A word about the latter, as the only kind of Oriental soft porcelain, and far older than any European translucent ware, may serve as introduction to to-night's discourse. This Persian porcelain occurs almost exclusively in three forms, namely:—(1.) Small white vases, bottles, and cups without other decoration than surface-mouldings; (2.) Open shallow bowls with rice-grain perforations filled in with the glaze, and often decorated with sparse simple lines of black, brown-purple, or blue; (3.) Bottles, cups, and other vessels having a blue ground and lustre decoration. The specimens of the first and second groups, and occasionally those of the third, consist of a highly siliceous granular paste, or body, washed over with a small quantity of a kaolinic substance, and rendered porcellanous, and remarkably translucent, by means of the penetration of the glaze into its whole substance from both surfaces. It may be compared to a piece of cartridge paper which has been thoroughly varnished, so far as the cause of its translucency is concerned. It now transmits a great part of the light which falls upon it, instead of regularly reflecting much, and "scattering" (by innumerable small irregular internal reflections) more. This ware has been fired at a low temperature, and shows, wherever the glaze has not saturated the body, how porous and fragile the latter is, and how easily discoloured. Pieces of Persian porcelain, belonging to group 2 above, were known in England as Gombroon ware. There are characteristic specimens both in the British Museum and in that of South Kensington.

Let me now direct your attention to the beginnings of the manufacture of porcelain in Europe. Of course, both hard and soft paste were inspired by the desire to reproduce the delightful material which the Chinese had so long made, and had adorned so exquisitely. The first approximate success was reached in the Medici translucent ware, which dates from 1581. In this three materials were associated, namely, the porcelain-clay of Tretto, near Vicenza, a fine sand, and a glassy frit. Specimens are extant at Sèvres, and in some Italian museums. Of the porcelain said to have been made at Venice as early as 1519, no authentic specimens have been recognised, but some good pieces of the period 1720-40 are known; these are of a very translucent glassy character. Cozzi was the better of two Venetian porcelain makers of the later period (1765). It is curious to note how the use of binoxide of tin in glass making has influenced much of this Venetian porcelain. Its smooth milky white, sometimes densely white, aspect, associated with a high degree of translucency, is to be attributed to the introduction of a stanniferous enamel. At Doccia a soft paste porcelain was made in 1735, and at Capo di Monte, Naples, in 1736. Italian workmen from the former factory introduced the manufacture of soft porcelain into Spain, (Buen Retiro) in 1760. On studying the paste and glaze of these Spanish and Italian porcelains, one is able to discern in some measure those relations between them which are due to the importation of methods, if not of materials, from one place to another. The soft paste made at Alcora, in Spain, differs from that of Buen Retiro, as might be expected from the circumstance that its manufacture was introduced, not by Italians from Capo di Monte, but by Germans from Dresden.

Belgium was somewhat late in the manufacture of porcelain, but Peterynck, of Lille, mixed a plastic clay with a clay marl and a glassy frit, obtaining thus a tenacious and durable paste. His "privilege" dates from April 3rd, 1751. The factory at Tournay was a success. Marieberg, in Sweden, possessed a small works, where soft paste porcelain was made. Of these wares, and of those which were manufactured at divers small places in Switzerland and Austria, there is little known, and nothing that I need here mention, for we shall have to discuss all the more important points connected with such productions, when speaking of those which were turned out from English and French factories.

And here, perhaps, I may suitably direct your attention to a subject on which much misapprehension exists. Although in true hard porcelain, if without colour, both Oriental and European, a hard body and a hard glaze go together, it is not unusual to find a great range of degrees of hardness in the glazes upon the so-called soft porcelains; for, provided the difficulty of unequal contraction be surmounted, there is nothing to prevent a soft and very fusible glaze, rich in alkalies or lead, from being applied to a china body of a considerable degree of hardness. So, on the other hand, one finds the soft, porous, nearly opaque body of old Bow porcelain, coated with a glaze much less easily abraded than itself. The one condition to be fulfilled is the greater resistance to the softening and fusing effect of heat, which the body must enjoy when compared with the glaze. It is needful to bear these facts in mind, when examining a piece of porcelain which is said to be "soft paste." Ascertain, by a file, or a piece of quartz or felspar, the hardness of the paste on some portion of the vessel free from glaze, and do not be content with any signs of attrition which the glaze may show. And it may be further noted that the removal of enamel colours by wear is by no means a sign of the porcelain body beneath being soft paste, but points rather to the hardness of the glaze, or to the

low temperature at which the painting on its surface has been fired.

On again returning to the subject of soft paste porcelain of foreign manufacture, I would direct your attention to the French works, as illustrated by the specimens before you. You will notice the resemblances which the productions of certain groups of these factories bear to each other. You will see the remarkable translucency, and almost gummy surface, of the early wares of St. Cloud, and Lille, and the Faubourg St. Honoré, Paris. Here are the allied products of Chantilly, and Mennecy-Villeroy, Orleans, and Sceaux. The employment of stanniferous washes to whiten the body, connects the early Chantilly porcelain with that of Venice. A chronological list of the chief French factories exhibits many points of interest, when we put representative specimens of each side by side.

1695. St. Cloud.	1753. Orleans.
1711. Lille.	1753. Sceaux.
1722. Paris: Faubourg St. Honoré.	1756. Sèvres.
1725. Chantilly.	1768. Etiolles.
1735. Mennecy-Villeroy.	1773. Bourg la Reine.
1745. Vincennes.	1784. Arras.

Many of these factories produced good wares, but want of technical skill, of artistic knowledge, and of suitable raw materials, offered in some cases serious drawbacks to assured and permanent success. The works at Vincennes were started about 1740, but for a few years were engaged in futile experiments, until about 1745. In 1753, they were reorganised, and in 1756 transferred to Sèvres. The paste, or body of the *Vieux Sèvres*, the *pâte tendre*, consists of eight parts marl, and seventeen of chalk, associated with seventy-five parts of a glassy frit, and covered with a lead-glaze. I give the composition of the frit and glaze, that the distinction subsisting between the composition of this variety of soft paste, and that of many English factories may be apparent.

The Sèvres frit consisted, in 100 parts, of—

Sand 60 parts	fused together and then washed.
Nitre 22 parts	
Common salt 7·2 parts ..	
Soda 3·6 parts	
Alum 3·6 parts	
Gypsum 3·6 parts	

The Sèvres glaze consisted in 100 parts—

Red lead or litharge, 88 parts	fused together and ground.
Sand, 27 parts...............	
Carbonate of potash, 15 parts	
Flint, 11 parts	
Carbonate of soda, 9 parts ..	

The body, after having been baked, was glazed and fired. Then the colours were applied by dusting on to the glazed surface, which had been previously covered with a thin film of fat oil of turpentine. Then the pieces are fired, and the process of dusting on the enamel colour is repeated—the piece being fired again. By repeating these two processes several times, the fine coloured grounds for which Sèvres was famous, were obtained. The bleu de roi, often marbled and veined with gold, was in early use; the bleu turquoise was invented in 1752, and the rose carné, or Pompadour, the violet pensée, the vert pomme, jaune claire, vert pré, and vert jaune, in 1857. The special beauty of old Sèvres lies not in the intrinsic excellence of the enamel colours, though this is high, but in the penetration of the glaze by the enamel ground-colours, and the rich but soft effect thereby produced—an effect which is enhanced by the special qualities of the soft and fusible paste beneath.

From old Sèvres let us turn to old Chelsea, the earlier productions of which show the presence of much vitreous matter, like the soft paste of the French factory. The date of the Chelsea works is not known. As, however, a high degree of excellence had been reached as early as 1745, evidence of this being afforded by the three specimens of "bee milk jugs" known to exist, all marked with an incised triangle and "Chelsea, 1745," engraved in the paste, it is incredible that the manufacture could have originated in that year. We know that in 1747 some Staffordshire potters went to Chelsea, but the notion that any improvement can be traced to this source is obviously erroneous. However, it would appear that they soon left the original factory, and set up an establishment of their own. We have data for arranging the productions of Chelsea according to these periods:—

Period I.—1745 (?) to 1757.
Period II.—1759 to 1769.
Period III.—1769 to 1784.

During period I., the porcelain was characterised by considerable translucency, much glassy grit being employed in the paste, and the glaze being also very soft. During the second period, the colouring was soft and yet rich, but the ware was less glassy, and the glaze rather more greenish. Towards the middle of this period (1764) Nicholas Sprimont, the owner, tried to sell the factory. It was then in most active operation, for a single year's production (over and above private sales) took sixteen days to dispose of by public auction. The catalogue of that auction comprised over 1,600 lots, and more than 6,500 pieces. In 1757, the works slackened and then ceased, the manufacture being resumed in 1759. From that date, all the ware was phosphatic; that is, it contained much bone-ash in the body, while the use of gold in decoration became more frequent and more lavish; figures with gilding upon them are not, indeed, so much as named in the sale catalogue of 1756. Here I may name and show you a peculiarity of the early Chelsea body (of period I.), which was, I believe, first recognised by Dr. Diamond. This white leafy saucer illustrates the characteristic to which I refer. On looking through it at a candle, we notice a number of moonlike discs scattered throughout the piece, and much more translucent than the rest of the body. They seem to be due to an irregular and excessive aggregation, in fact, of the vitreous frit which formed so large a constituent of the early Chelsea ware. Typical specimens of the second period are seen in the large vases (1764) in the British Museum; in the third period, when the works were in the possession of W. Duesbury, of Derby, the style became more ornate, and, in many instances, indistinguishable from that of Derby. Some suggestions as to the materials employed at the Chelsea works may be gathered from the following statements in Grosley's "Tour in London," "the sort of earth fit to make porcelain" was supplied by Cornwall to Chelsea: pounded glass was then used, and sand from Alum Bay. It will be recollected that Dorset

clay had been worked as early as 1666, and the clay of Bovey Tracey as early as 1730. But chemical analysis of authentic specimens of Chelsea confirms the separation I have made of Chelsea china into three periods, which may be respectively designated as—

I. The vitreous.
II. The phosphatic.
III. The kaolinic.

Something more about this will be seen further on.

Let us now turn to another famous English factory, that of Bow. The introduction of the characteristic constituent of what is often called by Continental authorities "natural or English soft porcelain," is usually attributed to Josiah Spode the younger, son of that Josiah Spode who, at first a workman, rose to considerable position and wealth, and who died in 1797. His son soon afterwards began making porcelain, and attained great excellence in smooth uniformity, truth of form, and fineness of glaze. He died in 1827, his partner, William Copeland, having died in 1826. Josiah Spode the third was the second son of Josiah Spode the second, but he only survived to carry on the porcelain manufacture for two years, his elder brother, J. Hammersley, being in business in London as Spode, Son, and Copeland. In 1833, S. T. Copeland bought the works at Stoke belonging to Spode; afterwards the firm became Copeland and Garrett.

It will thus be seen that no Spode porcelain can be earlier than 1797, probably not much earlier than 1800. If, then, we find phosphate of lime in porcelain of an earlier date, and of other manufacture, Spode's supposed introduction of bones into English porcelain paste—in fact his supposed invention of "natural or English soft porcelain"—falls to the ground. Now, chemical analysis of many specimens much earlier than any of Spode's make, proves this to have been the case. Bow, Chelsea, Worcester and Caughley, are all alike in this particular—all contain phosphate of lime from bones. The excavations in 1868, at the works of Messrs. Bell and Black, revealed many unglazed fragments and wasters which must have been made on the spot; some of these I have analysed completely, others I have tested; all tell the same tale. The patents speak in the same way. The 1744 specification of Heyly and Frye gives one part of potash, one of sand or flint and unaker. In 1749, T. Frye's patent names, in lieu of unaker (an earth from the Cherokee territory, U.S.), a virgin earth, produced by the calcination of certain "animals, vegetables, and fossils." This is directed to be mixed with flint or sand, and a certain proportion of pipe-clay. The glaze was made of red lead, saltpetre, and sand, with some white lead and smalts. There can be no difficulty in identifying the earth produced by the calcination of certain animal and vegetable matters, as bone-earth, or calcined bones, which is essentially phosphate of lime; but the patentee did not desire to be too explicit. Here are the analytical results confirming this deduction. They are obtained by means of a careful chemical examination of some fragments of unglazed porcelain of obviously early period, disinterred during draining operations at the works of Messrs. Bell and Black, at Bow:—

	Per cent.
Silica	40·0
Alumina, with a little oxide of iron	16·0
Lime	24·0
Phosphoric acid	17·3
Soda	1·3
Magnesia	·8
Potash	·6

The resemblance between the Bow and the Chelsea porcelain of the second period is confirmed by analysis of the latter which I have made. These have given me about 40 per cent. of silica, and 14 per cent. of phosphoric acid; but the Bow body is softer, indeed it may be easily cut with a knife, and the glaze, which takes colours well, is often *piqué avec points noirs*. The bottoms of vases and cups of Bow are often heavy and uneven; frequently they have been ground level. As all Caughley specimens, all Pennington's, most Staffordshire, and many Worcester, contain phosphate of lime, little use can be made of the easily-applied molybdic acid test for phosphoric acid, in order to determine the origin of a piece of old soft paste porcelain.

The Bow factory was an extensive one; according to Craft's well-known inscription in the British Museum, 300 hands were there employed. It may have been established earlier than the date of the first patent (1744), some say in 1730. The characteristic qualities, from an artistic point of view, of its productions resemble those of Chelsea porcelain, but they were not developed in all instances to the full extent possible; the penetration into the glaze of the enamel colours, and the warm luminous quality of the paste, are commendable features in Bow porcelain, but the frequent porosity of the body admitted of the ready absorption of grease, and of accidental colouring substances, which caused unsightly disfigurements. From what I have said, it will be evident that the characteristic ingredient of Bow porcelain was bone ash or phosphate of lime, which subsequently came into general use throughout the country.

A few of the recorded recipes for the manufacture of the body of ordinary English porcelain, during the last 40 or 50 years, will serve to show the important part which phosphate of lime plays in this composition:—

	i.	ii.	iii.	iv.	v.
Bone ash	47	46	46	40	36
China clay	34	23	23	30	21
China stone	—	28	31	30	31
Flint	—	—	—	—	12
Felspar	19	—	—	—	..
Glassy frit	..	3	—	—	..

Analyses of modern English porcelain, made about 1840, gave:—

Silica	40
Alumina	22 to 24
Lime	10 to 14
Phosphate of lime and iron	15 to 26
Alkalies	2 to 6

Thus far, I have spoken almost exclusively of the productions of Chelsea and Bow; a third great English factory demands some attention now. Worcester stands by itself in more particulars than one, but its survival for 130 years alone separates it from all other English factories in an exceptional way. In order to study the productions of the Worcester works intelligently, it is necessary to

note the changes of style and taste which occurred from time to time in the history of the porcelain works, and it is also necessary to observe the successive changes of composition, and consequently of effect, both in body and glaze. A convenient chronological arrangement of the Worcester periods is this:—

Old.	Modern.
I. 1751 to 1772.	IV. 1793 to 1807.
II. 1772 to 1783.	V. 1807 to 1813.
III. 1783 to 1793.	VI. 1813 to 1840.

From an artistic point of view the works of the old periods greatly transcend those of the modern. The lavish gilding, and the hard over-precise finish, which marked the productions of the closing years of the eighteenth century and of the later time, seemed to have deprived the decoration of Worcester china of all its original softness, freedom, and grace. The painters and gilders seemed to have been striving to emulate the rigid exactitude of the mechanical processes, which were coming day by day more into vogue. And they succeeded very well in suppressing the human element of their handiwork, and in making it gorgeous, precise, and uninteresting.

I am enabled, through the kindness of Mr. R. W. Binns, the learned and talented director of the Worcester Works, to give you the recipe for the manufacture of the earliest body made at Worcester; in fact, "The True Secret of Making Worcester Porcelain," a secret supposed to have been lost. This earliest body was a mixture of a prepared frit, with four other ingredients.

Worcester Body of 1st Period.

Frit	5 parts.
Flint	5 ,,
Crown glass	2 ,,
Hard soapy rock	1 ,,
Soft soapy rock	4½ ,,

The frit above-named was prepared from the following ingredients:—

Sand	40 parts.
Calcined flint	24 ,,
Potash	8 ,,
Smalt	1 ,,

During the second period the body contained:—

Frit	75 parts.
Whiting	15 ,,
Pipe clay	10 ,,

The frit here used being prepared from—

Sand	120 parts.
Soda	7 ,,
Alum	7 ,,
Salt	14 ,,
Nitre	40 ,,

The glaze used at Worcester in the second period was made from—

Red lead	38 parts.
Sand	27 ,,
Flint	11 ,,
Carbonate of potash	15 ,,
Carbonate of soda	9 ,,

When the supply of "soapy rock," that is, steatite and other hydrated magnesian silicates allied to serpentine (from Mullion, in Cornwall) failed, then bone ash, which is still largely used at Worcester, replaced it.

[The lecturer went on to describe the peculiarities of several specimens of old and modern Worcester porcelain, which were on the table.]

The following list of potteries where soft paste porcelain was made, is instructive in many ways, but has no pretension to completeness. The history of almost all manufactories has been a chequered one, and many have enjoyed but a very brief existence:—

1745 to 1849, Derby.	1795 to 1812, Pinxton.
1751 to ——, Worcester.	1813 to 1820, Nantgarw.
1756 to 1802, Lowestoft.	1814 to 1817, Swansea.
1772 to 1814, Caughley.	1820 to 1842, Swinton.

[The lecturer proceeded to illustrate the peculiar qualities of the porcelains produced at these factories by means of specimens on the table.]

I cannot conclude without expressing my best thanks for the loan of specimens, new and old, to Messrs. Minton, of Stoke, to Mr. R. W. Binns, of Worcester, to Messrs. Phillips, of Oxford-street, and to Mr. Litchfield, of Hanway-street.

Erratum in Lecture III.—The figure 3 has dropped, during printing, from the formula Fe_2O_3, on page 107, line 3.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

January 19.—"Causes of Success and Failure in Modern Gold Mining." By Alfred G. Lock, F.R.G.S. Hyde Clarke, Esq., will preside.

January 26.—"Five Years' Experience of the Working of the Trade Marks' Registration Act." By Edmund Johnson.

February 2.—"Trade Prospects." By Stephen Bourne.

February 9.—"The Present Condition of the Art of Wood-carving in England." By J. Hungerford Pollen.

February 16.—"The Participation of Labour in the Profits of Enterprise." By Sedley Taylor, M.A., late Fellow of Trinity College, Cambridge.

February 23.—"Recent Advances in Electric Lighting." By W. H. Preece, Pres. Soc. Tel. Eng.

March 2.—"Flashing Signals for Lighthouses." By Sir William Thomson, LL.D., F.R.S.

March 9.—"Improvements in the Treatment of Esparto for the Manufacture of Paper." By William Arnot, F.C.S.

March 16.—"The Manufacture of Aërated Waters." By T. P. Bruce Warren.

March 23.—"The Increasing Number of Deaths from Explosions, with an Examination of the Causes" By Cornelius Walford.

Dates not yet fixed:—

"Buying and Selling; its Nature and its Tools." By Prof. Bonamy Price. On this evening Lord Alfred S. Churchill will preside.

"The Discrimination and Artistic Use of Precious Stones." By Prof. A. H. Church, F.C.S.

"The Compound Air Engine." By Col. F. Beaumont, R.E.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

February 1.—"The Industrial Products of South Africa." By the Right Honourable Sir Henry Bartle Frere, Bart., G.C.B., G.C.S.I., D.C.L., LL.D., F.R.G.S., &c.

February 22.—"The Languages of South Africa." By Robert N. Cust.

March 15.—"The Loo Choo Islands." By Consul John A. Gubbins.

April 5.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

January 27.—"A New Mechanical Furnace, and a Continuous System of Manufacturing Sulphate of Soda." By James Mactear, F.C.S. J. C. Stevenson, M.P., will preside.

February 24.—"Deep Sea Investigation, and the Apparatus used in it." By J. G. Buchanan, F.R.S.E., F.C.S.

March 24.—"The Future Development of Electrical Appliances." By Prof. John Perry.

Indian Section.

Friday evenings, at eight o'clock:—

January 21.—"Forest Conservancy in India." By Sir Richard Temple, Bart., G.C.S.I.

February 11.—"The Gold Fields of India." By Hyde Clarke.

March 4.—"The Results of British Rule in India." By J. M. Maclean.

March 25.—"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Second Course will be on "Watchmaking," by Edward Rigg, M.A. Three Lectures.

Syllabus of the Course.

Lecture I.—February 7.

Introduction—Units of Time—Historical Sketch—Description of usual forms of watch—Escapements—Conditions of accurate timekeeping, and arrangements necessary for their maintenance in the higher class of watch.

Lecture II.—February 14.

The ordinary watch—Degree of accuracy required in it—Systems of manufacture in this country and abroad—Description of specimens illustrative of the various stages of construction—Comparison of the several systems.

Lecture III.—February 21.

Necessity of efforts to promote the art in this country—Need of education, theoretical and practical, in horology—Literature—Great want of uniformity in gauges, screws, &c.—Exhibition of ordinary and complicated watches, and of watchmakers' tools—Conclusion.

The Lectures will be illustrated by Specimens, Models, and Diagrams. The different movements, &c., will be shown enlarged on the screen by means of the Aphengescope and the Electric Light.

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

March 7, 14, 21, 28.

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Three Lectures.

April 25; May 2, 9.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

May 16, 23, 30.

Admission to Meetings.

Members have the right of attending all the Society's meetings and lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 17th...Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. C. R. Markham, "The Arctic Discoveries along the Coasts of Franz Josef Land, by Mr. B. Leigh Smith, in 1880."
British Architects, 9, Conduit-street, W., 8 p.m. Adjourned Discussion on Mr. E. C. Robin's Paper, "Sanitary Science in its Relation to Civil Architecture."
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Dr. Southall, "Pliocene Man in America," to be followed by a second Paper on the same, by Principal J. W. Dawson.
London Institution, Finsbury-circus, E.C., 5 p.m. Dr. W. Huggins, "The Photographic Spectra of Stars."

Tuesday, Jan. 18th...Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. A. Schäfer, "The Blood." (Lecture I.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Messrs. T. F. Brown and G. F. Adams, "Deep Winning of Coal in South Wales."
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. J. T. Danson, "Growth of the Human Body."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.

Wednesday, Jan. 19th ... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. A. G. Lock, "Causes of Success and Failure in Modern Gold Mining."
Meteorological, 25, Great George-street, S.W., 7 p.m. Annual General Meeting. Report of the Council, and Address by the President.
Geological, Burlington-house, W., 8 p.m. 1. Prof. P. M. Duncan, "The Coralliferous Series of Sind, and its Connexion with the last Upheaval of the Himalayas." 2. Mr. G. R. Vine, "Further Notes on the Family Diastoporidæ, Busk." 3. Mr. G. W. Shrubsole, "Further Notes on the Carboniferous Fenestellidæ."
Entomological, 11, Chandos-street, W., 7 p.m. Annual Meeting.
Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. J. Romilly Allen, "Notes on some Prehistoric Remains near Feating, Forfarshire."
Institute of Bankers (at the Theatre of the London Institution, Finsbury-circus. E.C.), 6 p.m. Mr. M. D. Chalmers, "The Codification of Mercantile Law, with especial reference to the Law of Negotiable Instruments."

Thursday, Jan. 20th...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. Edward J. Lowe, "Some Hybrid British Ferns." 2. Mr. William Phillips, "A Revision of the genus *Vibrissea.*
Chemical, Burlington-house, W., 8 p.m. 1. Dr. H. E. Armstrong, "Some Hydrocarbons present in Resin Spirit." 2. Mr. E. Vogel, "Determination of the Relative Weight of Single Molecules." 3. Dr. Arthur Downes, "The Oxidation of Organic Matter in Water." 4. Prof. Liversidge, "Analysis of Queensland Soils."
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. W. E. Ayrton, "The Production of Electricity."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. Francis Hueffer, "The Troubadours." (Lecture I.)
Royal Historical, 22, Albemarle-street, W., 8 p.m.
Numismatic, 4, St. Martin's-place, W., 7 p.m.
Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. J. Coates, "Applications of Hydraulic Machinery to Mines, Gas Works, Grain Warehouses, &c."

Friday, Jan. 21st...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Sir Richard Temple, "Forest Conservancy in India."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m., Dr. Warren De La Rue, "The Phenomena of the Electric Discharge with 14,400 Chloride of Silver Cells."

Saturday, Jan. 22nd...Physical, Science Schools, South Kensington, S.W., 3 p.m. Mr. R. T. Glazebrook, "The Measurement of Small Resistances," and "A Method of Comparing the Capacities of Two Condensers."
Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sidney Colvin, "The Amazons." (Lecture I.)

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, JANUARY 21, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ADJOURNMENT OF MEETING.

In consequence of the small attendance at the Ordinary Meeting, last Wednesday, 19th inst. (owing to the inclemency of the weather), the discussion on Mr. Alfred G. Lock's paper, "Causes of Success and Failure in Modern Gold Mining," was adjourned to Monday evening, 24th inst., at 8 p.m. Cards of invitation issued for the meeting will be available for next Monday.

LABEL FOR PLANTS.

The Council are prepared to award a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

The award will be made on the recommendation of a committee, which will be appointed for the purpose by the Council.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary not later than the 1st May, 1881.

The Council reserve to themselves the right of withholding the Medal and Prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

(By order)

H. Trueman Wood, Secretary.

PROCEEDINGS OF THE SOCIETY.

SEVENTH ORDINARY MEETING.

Wednesday, January 19th, 1881; B. Francis Cobb, Treasurer of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Barker, George E., Sutherland-villa, Chiswick.
Barlow, Walter Alfred, 6, St. Paul's-churchyard, E.C.
Buchan, William Paton, 21, Renfrew-street, Glasgow.
Burt, Frederick, F.R.G.S., Woodstock, Crescent-road, Crouch-end.
Temple, Sir Richard, Bart., G.C.S.I., C.I.E., D.C.L., The Nash, near Worcester.
Tovey, Major Hamilton, R.E., Waltham Abbey, Essex.

The following candidates were balloted for, and duly elected members of the Society:—

Andrew, Capt. C. W., 286, Kennington-park-rd., S.E.
Bayliss, Samuel, 5, Victoria-street, Westminster, S.W.
Browne, Miss Annie Leigh, 58, Porchester-terrace, W.
Johore, The Maharaja of, Singapore.
Keymer, H. J. C., Marine-cottage, Gorleston, and Gorleston-docks, Great Yarmouth.
Reid, Arthur G., M.D., Thatched House Club, St. James's-street, S.W.
Rigg, Arthur, 71, Warrington-crescent, Maida-vale, W.
Taylor, George Noble, 3, Clarendon-place, Hyde-pk., W.
Wiseman, William Percival, Cumberland-house, West Pennard, Glastonbury.
Wragge, Clement Lindley, F.R.G.S., Farley, near Cheadle, Staffordshire, and Adelaide, South Australia.

The Chairman said, as there were so few present owing to the severe weather, it was proposed that the paper should now be read, and the discussion adjourned to Monday next.

The paper read was on—

CAUSES OF SUCCESS AND FAILURE IN MODERN GOLD MINING.

By Alfred G. Lock, F.R.G.S.

The working of gold mines is usually the earliest and the most rapidly remunerative enterprise developed in the countries where they exist, doubtless from the fact that their produce is unaffected by those conditions which have more or less influence upon almost every other production of nature or art, viz., cost of transport, depreciation by time, and fluctuation of market value. Gold mining is often the first incentive to the occupation of new lands, and has been the primary cause of the progress of our most important colonies.

The "Stock Exchange Year Book" for 1880, reveals the fact that £2,240,449 of English share capital was invested in so-called "gold-mining" enterprises at the end of 1879. An analysis of this sum shows it to be composed of—

£871,658	which has never paid a dividend.
362,041	which has paid none for some years past.
110,000	which is paying about 3 per cent.
896,750	which is paying 10–50 per cent.
£2,240,449	

In other words, more than half this large amount is utterly unremunerative. Probably this fact has done much towards creating the popular notion

that gold mining is a very speculative and uncertain enterprise; whereas in fact, none is safer or more highly profitable, when properly conducted. The recent favour shown by the public towards Indian and other gold mines, seems to warrant the selection of the present occasion for a consideration of some of the causes that determine the success or failure of their working. These may be divided at starting into three distinct heads:—

1. The soundness of the constitution of the undertaking.

2. The presence of gold in the property, and the existence of the ordinary facilities for mining operations.

3. The knowledge of how to extract the gold in the property, and the provision of suitable appliances for the purpose.

Given the two first essentials, the problem is to apply the third.

Before proceeding to deal with this question, it will be necessary very briefly to glance at the several conditions under which gold occurs.

Occurrence of Gold.

These are three—(1.) In the form of scattered grains and nuggets, in alluvial deposits, having been liberated by natural causes from its original matrix; (2.) In the form of grains and leaves, in mineral veins (principally quartz), still enveloped in its matrix, but not associated with any other metals, and technically known as "free" gold; (3.) In the form of grains, imbedded in and most intimately associated with (not chemically combined with) various other metallic compounds, chiefly sulphides and arsenides, and commonly known by the comprehensive term "pyrites," disseminated throughout veins of quartz or other mineral. The first class I shall pass over, as, though of equal importance with the rest, there is less difficulty and expense in treating it. Our attention will be confined to the free gold and the pyritous gold found in mineral veins.

Treatment of the Vein-stuff for Rendering Separable the Free and Pyritous Gold.

The mere mining operations entailed in obtaining the auriferous rock may be passed over without any discussion, as being thoroughly well understood and carried out. We may proceed at once to the treatment of the material when mined, in discussing which treatment I shall refer, where necessary, to those systems which ought not to be admitted, and shall explain the reasons why they are not admissible.

The first process of the treatment is the disintegration of the material, to such a degree of fineness as will enable the gold and the pyrites to be liberated from the non-auriferous portions of the mass.

Crushing and Stamping.—The disintegration of the mineral is conducted in an establishment known as the "reduction works." The ore, being reduced to a suitable size, is submitted to the pounding action of a series of "stamps."

These are heavy iron pestles, lifted to a height of some inches, and allowed to fall upon the ore intended to be crushed. They work in a "mortar" or "coffer," an iron trough, constantly supplied with ore and water, from which the crushed material escapes, as soon as it is reduced to the desired degree of fineness, through the meshes of closely-fitting screens. The mortar is generally rectangular in form, and contains a set (usually five) of stamps, constituting a "battery." The mortars should be securely fastened to a solid foundation of heavy timber, so as to prevent jarring when at work. The stamps are established in a substantial framework, and are lifted by means of revolving "cams" or "wipers." The stamps should be round, never square, and each head should rotate, making part of a revolution each time it is lifted. It was, at one time, objected that the effective capacity of round stamps was less than that of square ones; but it has been proved, by careful experiments under like conditions, that they are equal in that respect, whilst the wear and tear is lessened by the revolution. Their weight and lift, and the speed at which they are driven, vary in almost every reduction works, opinions being greatly divided on each of these points. Their proper adaptation to the ore under treatment has an important influence upon the success of the operation.

The weight of stamps ranges, in Victoria, from 224 to 1,232 lbs. per head. Although a medium weight of 560 to 672 lbs. is found in most instances to best suit the character of the ore, yet, in others, a higher figure may be necessitated. In America, the weight varies from 700 to 950 lbs.

The height of drop or fall varies from 2 to 11 inches in Victoria, and from 7 to 11 inches in America. It should not be less than 7 inches, and may be advantageously increased if the stamps are light.

The speed differs in like manner: in Victoria, it varies from 45 to 85 blows per minute (75 to 80 being generally considered best); in America, from 70 to 100.

The order in which the stamps drop varies in different mills, but the desired conditions are (1), that the work of raising the stamps shall be uniformly distributed on the cam-shaft, so that the weight lifted may be, as nearly as possible, the same at any period of the revolution; and (2), that each stamp shall fall effectively upon the material to be crushed, and maintain its proper distribution. If the stamps were allowed to rise and fall in regular succession, from one end of the battery to the other, the material would accumulate at one end, and the effective duty of all the stamps would be greatly diminished. In a five-stamp battery, a common sequence is (1) the middle stamp, (2) the end one on the right, (3) the second on the left, (4) the second on the right, (5) the end one on the left. Another, which makes a backward and forward wave, and thus keeps the mortar very evenly filled, is (1) the middle stamp, (2) the second on the right, (3) the end one on the right, (4) the second on the left, (5) the end one on the left. In other mills, the end stamps are dropped first, thus, (1) the end stamp on the left, (2) the end one on the right, (3) the second on the left, (4) the second on the right, (5) the middle one. It is thought that the middle stamp dropping first secures the greatest discharge, and that the end stamps dropping first ensures the greatest quantity being stamped.

The action of the stamps in the presence of water is to reduce the material to such a degree of fineness as will enable it to flow off with the water, which flashes up at each blow of the stamps,

through the screens placed at the exit from the mortar. The prompt escape of this fine material is of great importance; consequently, the arrangement should admit of both a back and front discharge. This fact has been overlooked even in some of the batteries most recently despatched to the Indian gold-fields, which were provided with one escape only, and had their effectiveness thus reduced by one-half.

The "gauge," or number of perforations of the gratings, or screens, varies in different works: in Victoria, from 60 up to 800 holes per square inch; in America, from 900 to 10,000 holes per square inch. As this determines the degree of disintegration to which the material is subjected, it should be regulated by the character of the gold contained in the material, and should always be sufficiently fine to ensure the liberation of the auriferous particles. Care must be taken, on the other hand, that it is not so fine as to cause a difficulty in arresting the particles. For reasons to be explained presently, I am of opinion that 400 holes per square inch should not be exceeded.

In order to save the mortars from wear and tear, iron dies, or false bottoms, are placed on them, to receive the blows from the stamps. In America, they are generally of cast iron, and rest directly on the mortar. In Victoria, the much better plan is adopted of allowing the dies to rest upon a layer, at least three inches thick, of finely broken quartz. By having dies of the same size as the stamp-heads placed on this layer of quartz gravel, an opportunity is provided for the liberated gold particles to get into the gravel, out of reach of the stamps, and thence they are easily recovered.

The character of the blow demands attention. The hardness of the mineral containing gold is always so much greater than that of gold itself, or even of auriferous pyrites, that the same amount of stamping on the three substances will render the two latter much finer than the former. But it is of the most importance to prevent the gold from being smashed too fine, or beaten flat, for in those conditions it is very liable to be lost. The tendency of slow heavy blows is to flatten the gold particles, while that of smart light blows is to effect disintegration without materially altering the shape of the particles.

The effectiveness of the stamps is largely dependent upon the regularity with which they are supplied with ore. This is frequently done by hand labour, which has many advocates; but labour is saved, wear and tear are lessened, and usually greater regularity is ensured, by using a self-feeding apparatus. This consists of a hopper, filled with ore, from which an inclined trough leads to the battery; this trough, agitated by the stamps, discharges its contents gradually into the battery.

The trough supplying water to the battery is generally placed under the self-feeding apparatus. The quantity used is in proportion to the character of the ore, and the degree of fineness to which it is crushed. In Victoria, it varies from 30 to 1,200 gallons per stamp-head per hour, though 300 to 500 may be reckoned as satisfying all requirements. In America, on the other hand, about 93 gallons per stamp-head per hour is generally thought sufficient.

It is evident that the weight and speed of the stamps, and the height of their lift, united to the number of holes per square inch in the screens, chiefly determine the "duty" of the stamps, or the quantity of ore crushed per 24 hours. Accordingly, in Victoria, it varies from 1 ton to 3 ton 13 cwt.: the Port Philip Company's 6-cwt. stamps, giving 75 blows per minute, and requiring 1 h.p. per head, crush an average of 2 tons 4 cwt. each per 24 hours; and their 8-cwt. stamps, making 75 blows, and taking $1\frac{1}{4}$ h.p., average over 3 tons in actual practice. In America, the quantity varies from 1 ton to (in some few instances) as high as 3 tons per 24 hours.

I would here direct attention to a class of stamps recently brought into notice, which, though requiring certain modifications to fit them for gold ore crushing, yet are decidedly a step in the right direction—I refer to W. Rasche's, of Melbourne, "direct acting" battery, Husband's and Sholl's Pneumatic stamps, and Patterson's "Elephant" stamps. They are all based upon one principle: the battery consists of two stamps only, driven at a great speed (150 to 200 blows per minute), and weighing only 2 to 4 cwt. each, their main differences lying in the means adopted for securing the speed. The perfection of stamping, so far as quantity is concerned, would be gained by allowing each stamp in a battery to work independently, and to surrouud it on all sides by screens. One reason why some of the stamps in Victoria and America crush so much more than others is, that they have screens both at the back and at the front of the battery.

An excellent little stamp for prospecting purposes has been quite lately invented by Dunham. It can be driven by mule or hand power, and is exceedingly portable; the stamp is surrounded by screens, and, consequently, permits the maximum of duty to be reached.

Appliances for Arresting the Gold (both Free and Pyritous) Rendered Separable by the Stamping Operation.

Having treated of the means by which the auriferous material is disintegrated, it will next be necessary to describe the appliances used for separating the free gold and pyrites from the other finely divided matters, in whose company they leave the battery. This separation is effected by a combination of two distinct processes:—(1.) The first consists in directing the components of the mass through, over, or among a body of mercury, which metal possesses the peculiar property of absorbing the particles of free gold. This absorption is known as "amalgamation," and as it constitutes the most certain and satisfactory method of collecting the minute particles of gold, from which the mercury can be separated afterwards without loss, the object of all the processes employed is, or should be, to bring the gold into a fit condition to be amalgamated, when it is not already in that condition. (2.) The second process is the provision of a number of checks or obstructions to the onward flow of the matters, with the object of presenting abundant opportunities for the greater specific gravity of the most valuable portions of the mass to exert itself, causing them to be arrested, while the worthless matters and a portion of the pyrites flow away to undergo further treatment.

Mercury Methods.—There are three essentially different methods of applying mercury for the re-

covery of the free gold at this stage of the treatment. That most widely used originated in America; it consists in placing a quantity of mercury in the coffers of the stamps, so that it may be pounded up with the material, supplementing this by a considerable area of so-called "amalgamated copper plates," for catching both the free gold which has escaped the mercury and also that which has formed an amalgam with it. The mercury introduced into the batteries is added in small quantities from time to time, according to the richness of the material and the rapidity with which amalgam is formed. The amalgamated plates are formed by a somewhat delicate and tedious process, of covering one side of pieces of sheet copper (more recently electro-silvered) with a coating of mercury. That portion of the interior of the batteries which is not occupied by the screens, is lined with these plates, fixed in an inclined position, and so as to be readily removed and replaced. By the churning that takes place in the battery, particles of gold, mercury, and amalgam are splashed up on these plates, and attach themselves to the surfaces, which are periodically cleaned. Outside the batteries are placed tables, covered with similar amalgamated plates, adjusted at such an inclination as will permit a ready flow of the materials over the surface, without being so rapid as to wash away the gold and amalgam, or prevent their adhesion to the plate. The inclination necessarily differs according to the supply of water, and other conditions. The gold and amalgam collected on these plates are removed in the same way as from the others. The matters not retained by the plates escape with the "tailings," the treatment of which will receive special attention presently.

I venture to assert that this system of putting mercury into the stamp coffers, and using amalgamated plates, is radically wrong. First, as to the former. Even supposing the ore under treatment to contain no pyrites whatever, a condition which is probably never met with in practice, the stamping up of the mercury is alone a cause of great loss of that valuable commodity. But where pyrites is present, there is incurred the additional evil that the pyrites grains form a coating over the globules of mercury and amalgam, or cause "flouring," as it is technically called, thereby producing a triple loss—a loss of gold which has not been amalgamated, of gold which has, and of mercury—for no effective method has yet been found for catching this "floured" stuff. As to the amalgamated plates, it is an incontestible fact that they do not catch such a proportion of the gold as to render them of any real service. Probably the highest portion of the gold caught by them never exceeds 55 per cent.; and when other appliances are not used in conjunction, the loss of gold may amount to half of the total contained in the ore. It may be safely said that their use has been abandoned on all properties where any pretence is made of saving above 80 per cent. of the ascertained contents of the ore.

The second means of exposing mercury to the crushed material may be divided into two heads—mercury "ripples," or "riffles," and mercury "troughs." Mercury ripples consist of grooves cut across the "ripple-board tables," inclined planes of wood, varying in length, and placed in the route of the materials leaving the stamps. These grooves are cut about 2½ feet apart, and are 1 inch deep at the lower side, diminishing till they are flush with the surface of the bath at the upper edge, and about 3 inches wide. While at work, they are kept nearly full of mercury. They are generally used in combination with blanket-tables, and are most favoured in Australia. The mercury trough may also be considered as essentially Australian. A very effective arrangement of blanket-tables and mercury troughs, adopted by the largest Victorian companies, is as follows:—The material leaving the stamps is led into a trough, having a perforated plate at the bottom to keep back any coarse stuff, by which it is easily distributed; thence it passes into three connected troughs, containing mercury, dropping from the first into the second, and from the second into the third. Each of these troughs is fitted with a splash-board, which, reaching down to within a certain distance of the bottom, compels the falling matter to penetrate the mercury more or less, before escaping over the lip of the trough. Each trough has a tap-hole on one side, by means of which the amalgam may be drawn off. The whole of the contrivance is under lock and key, which prevents stealing. At the end of the blanket-table, another similar trough is placed, through which the material passes before entering the waste-trough. The amalgam formed in all these troughs is periodically removed.

The third plan of amalgamating at this stage is by grinding the crushed material with mercury in little mills, as in Hungary. The same objections apply to this, as to the system of introducing mercury into the material under the stamps.

Blanket-tables.—The representative of the second class of appliance is the "blanket-table." This consists of a wooden floor, stretching across in front of the batteries, with a varying length, and laid at a varying pitch or incline. It is fixed securely, and in such a manner as to enable the pitch to be altered, always observing the utmost regularity in its arrangement, and ensuring precisely the same degree of pitch throughout the entire length. The surface of the table is made perfectly smooth and true. By means of narrow strips of wood fastened to the floor, it is subdivided into "strakes," one for each stamp in the battery. Sometimes the table is broken transversely, into sections of three feet or so, the upper edge of each section being about two inches below the over-lapping edge of the next above. The surface is covered throughout with closely woven baize or blanket, laid on with extreme care, so as to lie flat, and cling to the boards.

The mixture of water and disintegrated matters leaving the battery, passes over the surface of the blanketing in a thin stream. The specific gravity of the gold and pyrites causes them to descend to the lowest stratum of this stream, by which they are brought into contact with the fibres of the blanketing, and are induced to settle among them. From these, they are subsequently dislodged by washing in clean water.

Many conditions govern the success or failure of this apparatus. (1.) When the gold is stamped to an excessive degree of fineness, or is flattened into tiny thin plates, it becomes what is known as "float" gold, *i.e.*, owing to the minutenes of the

particles, or their flattened shape, they lose the effect of their great specific gravity, and actually float away. Hence the fallacy of too fine stamping. (2.) The supply of water, received through the battery, must be exactly adapted to the nature of the material under treatment; if too little, the material will be unevenly distributed, and will clog the blankets; if too great, it will wash away the gold. (3.) The excessive inclination of the tables is often a source of great loss; it should scarcely ever be greater than one in 14-16. (4.) The length of the table is of importance in reducing the inevitable loss to a minimum; for, though by far the largest proportion of the valuable matters is deposited on the first few feet of the strakes, yet, however far the latter may be continued, they will always catch some particles. In practice, it would be inconvenient to much exceed 30 feet, but 20 feet should be regarded as a minimum figure. (5.) The interstices of the blanketing would, in course of time, become choked with heavy matters, and would then cease to be a receptacle. The renewing and washing must, therefore, be performed at sufficiently short intervals. The frequency with which this is repeated will much depend upon the character of the material, being increased when it is "slimy," and when much pyrites is present. The first series of blankets may need changing every hour, or even oftener, the second every two hours or so, and the remainder every six to twelve hours. Much gold is lost through slovenliness in this department. (6.) Sufficient care is not generally exercised in the selection of the fibrous material used for covering the strakes; and experiments with various kinds of hair and wool, and with different classes of fabric, may be expected to throw considerable light upon the subject.

Treatment of the Blanket-sand.

Barrel Amalgamation.—The material gathered from the blanket-strakes, consisting of grains of free gold, globules of mercury, and particles of amalgam, which have been splashed or washed from the troughs, ripples, or plates, with a large quantity of pyrites and some worthless material, and collectively termed "blanket-sand," is usually treated with mercury in a revolving barrel, the process being known as "barrel amalgamation." When the proportion of free gold is considerable, and the operation is properly conducted, it gives most satisfactory results. The barrels are of wood or iron, and are constructed to revolve on a pivot at each end. The charge is 8 to 10 cwt. of the damp blanket-sand, and 200 to 300 lbs. of mercury; the barrel is then set to revolve for about eight hours, at a speed of 14 to 16 revolutions a minute. After this, it is filled up with hot water, and set to revolve again for another four hours, at a rate of 5 or 6 revolutions a minute. This concludes the operation, and the charge may be drawn off. The free mercury and most of the amalgam are withdrawn first. The remainder of the contents is sent to a shaking-table, or some similar contrivance for effecting the separation of the amalgam, pyrites, and refuse. The two latter are treated the same as the "tailings." Stones and pieces of iron are sometimes put into the barrel, with the erroneous idea that they grind the sand finer, and aid the amalgamation. This should on no account be done, as, with pyrites present, the grinding will inevitably cause sickening or flouring of the mercury. When very little free gold is present, it is a better plan to treat the blanket-sand in the same manner as the concentrated tailings, to be described hereafter.

Treatment of the "Tailings."

All the stamped material remaining beyond the portions which are caught by the blankets, plates, ripples, and troughs, is collectively known as "tailings." It consists principally of fine earthy matters, but contains also more or less of gold, amalgam, mercury, and pyrites, chiefly the last. In some instances, especially when the ore contains a large proportion of pyrites, the tailings have a very high value; in all cases, the recovery of the gold contained in them demands the earnest attention of the miner who desires to achieve success. Unfortunately their treatment is full of difficulty, and hence the only too frequent disposition to neglect them totally or partially. It is only where the poverty of the ores renders it compulsory to extract all the precious metal they contain, in order to give a remunerative yield, that any really effective and economical plans have been devised for the purpose. Where the ores are sufficiently rich to pay a good profit from the more easily extracted portion, little attention has been given to this question. But the knowledge gained in one region should be applied in all, and there is no excuse for throwing away a quantity of gold because the mine happens to pay well without it. Such an undertaking must be undoubtedly catalogued among the failures, whatever profits it may return.

Settling-boxes.—The sands, pyrites, slime and water, which have escaped from the blankets and the last mercury-trough into the waste-trough, pass direct to "settling-boxes," where the current is checked, and the heavier material settles. These boxes are generally cleaned out every few hours, and the material is passed on at once to some machine for concentration. The fallacy of this step will be evident, when we consider that all methods for the mechanical concentration of ores by means of water, based upon the fact that the ore is specifically heavier than the refuse, can only fully succeed when that superior weight of the ore is most thoroughly availed of. I have previously alluded to the fact that the relatively greater specific gravity of the particles may lose its effect in the presence of material of disproportionate size and shape. The latter feature cannot be controlled, as it is determined during the process of crushing; but for the classification of the grains according to size, at least within certain limits, a number of contrivances have been invented, and are in every-day use in Europe, for the concentration of such heavy ores as galena, tin ore, &c. Their value for application to the treatment of auriferous pyrites is intensified by the fact that the gravity of the latter, as compared with that of quartz, presents far less contrast than does that of lead or tin ore to its gangue; besides, the pyrites is so much softer and more brittle than the quartz, that it is crushed relatively much finer. For these reasons, the "sizing" of the tailings, before any attempt is made to concentrate

their valuable portion, must evidently be of considerable advantage.

Sizing.—Of the contrivances for classifying according to size, the most exact are probably inclined, rotating, sieve drums. In these, the material is introduced at the higher end, and passes through finer and coarser sieves in succession. But the objection to their use is that they require a considerable amount of attention, so that they are not suited for a country where labour is dear; nor have they the capacity for treating the large bulk of material which accumulates at many of the great gold mines.

The foremost authorities in Australia recommend separation into three sizes, each to be treated distinctly afterwards. Some speak highly of German "pyramidal boxes," and "triangular double troughs." The "pyramidal box" consists of a series of V-shaped troughs, increasing in size towards the outlet, over which a stream of water and material is constantly passed. The heaviest particles fall in the first box, the next heaviest in the second, and so on. The "triangular double trough" has the same object in view. It consists of two or more consecutive V-shaped troughs, into which are fitted triangular stops, which compel the stream of water and material entering at one end to perform a series of descents and ascents. The heavy matters are deposited at the bottom of the trough, while the lighter matters are carried up by the force of the water.

Concentration or Separation.—Having classified the material according to size, the next step is to submit each separate size to a process of concentration, with the object of eliminating the valuable portion. For this purpose, many machines are in use. A description of them all would occupy too great space here, but they will receive attention in my forthcoming book. Probably the most perfect, and one which is said by some in Australia to save [illegible] per cent. of the pyrites present, is Borlase's "buddle," fitted with Munday's "scrapers." It consists of a circular wooden trough, 18 to 24 ft. in diameter and about 1 ft. 6 in. deep. The crushed material, with additional water, is conveyed into a box in the centre of the trough, from which it escapes by revolving pipes, and comes into contact with the sides of the trough. In flowing over the sloping floor of the buddle, the pyrites, from their greater specific gravity, become separated, and are deposited upon the floor, whilst the lighter refuse substances are carried away through a discharge pipe. Several rims or stops are placed on the floor to facilitate the collection of the pyrites, which, as collected, is constantly levelled and distributed by the scrapers, which are set at a suitable angle, and revolve with the shaft. When they descend too deep, owing to the quantity of pyrites collected, they are raised by screws. Attention to the quantity of water and crushed material flowing into the buddle, and the speed at which it revolves, are essential to obtain the best results. The various so-called separators or concentrators, of which I have described one as a type, effect the separation of the pyrites from the gangue or refuse, or, in other words, concentrate the pyrites by elimination of the refuse matters.

Treatment of the Pyrites.

Having secured the pyrites in a fairly clean condition, the next step is to extract the gold contained in them. This is often conducted as a separate industry, especially where the proportion of pyrites yielded by the ores is too small to permit of each mine maintaining an establishment for the purpose, and where the necessary facilities—cheap fuel and skilled labour—do not exist.

Under this section, will be included the treatment of all compounds of the baser metals, in whose association gold is found. The treatment of all ores will have been pretty much the same up to this point, whether the gold were in a free state, or associated with various metallic sulphides, arsenides, &c. Of course, should the ore contain no fine gold whatever, the mercury methods might be dispensed with; but the blanket-tables, sizers, and concentrators will need more than usual attention.

The gold found in these ores is probably always in a native state, that is to say, it is not in chemical combination, though the mechanical association may be exceedingly close. In some instances, indeed, the grains of gold are covered by a microscopically fine film of sulphide, sufficient to prevent actual contact between the gold and mercury. This fact, combined with what has been previously said about the flouring of mercury placed in the stamper boxes, by reason of the sulphides met with, points conclusively to the error of attempting to effect amalgamation of the gold in such ores by means of grinding with mercury, for not only will much of the gold be lost, but much mercury will be floured and also lost.

It may be taken as an established fact that the first step necessary to the recovery of the gold from such compounds is the oxidation of the sulphides, arsenides, or other compounds which hold it prisoner. The least experienced gold-miner knows that pyrites which has been exposed in heaps for years to the weather, yields a far greater per-centage of gold than it did when first placed in the heap, the gold having been liberated by the oxidation caused by the exposure. But this is necessarily a very slow process, and not quite a perfect one. A more rapid and effectual way of securing the same result is by roasting the material in a reverberatory furnace, so as to volatilize the sulphur, &c. These furnaces are constructed on many plans. The one adopted by some of the largest and most advanced works in Australia is the inclined reverberatory furnace of Latta and Thompson. It only requires one man per shift to work it. It consists of a fire-box at the lowest end, from which the heat passes over the pyrites on the hearth. It has doors on each side, by means of which the pyrites are gradually drawn down over the hearth, beginning with the hopper which supplies the pyrites, and which is situated at the higher end of it, until they reach the bottom, where they fall into a channel, whence they are drawn into a pit. The labour may be reduced by making the furnace in three sections at right angles to each other, so as to facilitate the operation of working the charge through. The roasting must be continued until all the sulphur and arsenic are driven off, and the pyrites become "sweet;" but the heat must not be carried too high, nor is it necessary to convert all the iron into sesquioxide. The time occupied in the operation is 12 to 18 hours, but efficiency must not be

sacrificed to time, for partially decomposed pyrites cause more "flouring" of the mercury, and greater loss of gold and amalgam in the succeeding operation, than undecomposed pyrites. The "sweetness" is judged by the material emitting neither smell nor fumes, by giving off no sparks whilst hot, by its turning red when cold, and by its ceasing to run easily when stirred. About 4 to $4\frac{1}{2}$ tons of pyrites can be treated in a day in such a furnace. The consumption of fuel will much depend upon the regular feeding of the fire. Great attention must also be paid to the draught of the furnace, as it is essential that a steady current of air should pass over the surface of the pyrites, to ensure their thorough oxidation, and some plan must be adopted to effect this. Opinions are divided as to whether the presence of a small per-centage of sand with the pyrites is detrimental or beneficial; on the one side, it is maintained that the sand tends to check the agglutination or "caking" of the particles, which, when once begun, makes it very difficult, if not impossible, to roast properly; on the other hand, it is contended that the sand cuts up the mercury, and causes a great loss in the subsequent process of amalgamation, especially if a Chilian mill is used. Mixing charcoal with the pyrites in roasting promotes their decomposition by the combination of the carbon with the sulphur, but a good furnace properly attended requires no such aid, and when lead or antimony are present in the pyrites, the carbon acts injuriously (by reducing the metals).

Another furnace which is highly spoken of is the revolving furnace. It consists of a fire-box, whence the heat and products of combustion traverse an iron tube, lined with fire-bricks, supported at an inclination which varies with the character of the ore. It rests upon friction wheels, and is rotated by gearing at the lower end; it passes into the fire-chamber, and is so arranged as to deliver the ore passing through it by an opening into the chamber. At the upper end, it communicates with flues or condensing chambers. The ore, dried on the plates covering the condensing chambers, is fed into a hopper by a boy, who also attends to the fire. The tube makes three to eight revolutions a minute; in its progress, it raises the ore by four projecting shelves parallel with its axis, whence the ore falls off in thin streams through the heated gases in the tube. The sulphur and arsenic thus ignite, and burn so freely that much of the former, and more of the latter, will have escaped before the ore has arrived half-way along the tube, and the heat evolved by this combustion is available for heating the upper portion of the tube. The advantages of this furnace are—saving of labour for distributing the pyrites, and the completeness with which the distribution is effected.

Amalgamation.—The object of simple roasting is to free the gold from its companionship, and render it susceptible of amalgamation. In order to effect the latter, the roasted pyrites are ground with mercury in Chilian mills, in Arrastras, or in Wheeler's or Hepburn and Peterson's pans, &c. The object in all is to break up the mercury, and cause its thorough penetration of the sand operated on, so that it may take up all the gold brought into contact with it. The successful conduct of the process is by no means easy, for the very means adopted to secure effective amalgamation give rise to a flouring of the mercury, brought about by mechanical action, and causing a great loss of mercury during the subsequent operation of flushing off. Several specifics have been proposed for lessening this loss. "Sodium amalgam" keeps the surface of the mercury bright and quick, owing to the gradual oxidation of the sodium, and is by many considered to prevent flouring, and to assist in collecting the mercury when floured; by others, it is thought to gather base metals, and to cause a loss of mercury. It is probable that more watchfulness and attention to its peculiar properties would make it more generally successful. Solution of soda is useful for freeing the gold particles from grease; the same is more or less true of solution of potash and of lime. Potassium cyanide prevents flouring, and keeps the mercury bright. Of the acids, sulphuric acid acts better than either nitric or hydrochloric.

The matters taken from the amalgamator, of whatever kind, are next passed through a concentrator, or, better, through two in succession, and then through a mercury trough, the tail-sand being run through buddles. The proportion of the gold saved from the pyrites by the proper use of these contrivances has been as high as 95 to $98\frac{1}{2}$ per cent.

Pyrites may consist of the following distinct minerals:—

	Specific gravity.
1. Iron pyrites (mundic)	4·8 — 5·2
2. Magnetic pyrites (pyrrhotine)	4·4 — 4·7
3. Arsenical pyrites (mispickel)	6·0 — 6·4
4. Copper pyrites (chalcopyrite)	4·1 — 4·3
5. Sulphide of antimony (stibnite)	4·5 — 4·6
6. Sulphide of lead (galena)	7·2 — 7·7
7. Sulphide of zinc (blende)	3·9 — 4·2

Other rarer compounds are also sometimes found, but only in such small quantities as not to interfere with any process adopted, and they will not be considered in this paper.

The most common form is a mixture of iron, magnetic, arsenical, and copper pyrites, in which any one of these may largely predominate, or be entirely absent. It is usually found that the gold exists in one or two only of the components of the mass, and not in the others. Where the gold is absent from the magnetic and copper pyrites, and present in the iron and arsenical pyrites, these may often be separated by mechanical dressing, based upon the difference in specific gravity. Where this is impossible, and the copper pyrites are sufficiently abundant and valuable to treat, Mr. Cosmo Newbery—who has a great reputation in Victoria—recommends the wet method of copper extraction, leaving the gold to be obtained by the ordinary amalgamation process, instead of smelting.

But it is only within the last few years that any process has been found for extracting the gold from ores containing sulphide of antimony, and many highly auriferous mines in Victoria have been stopped for want of such. In 1873, Messrs. Cosmo Newbery, Ulrich, and Brown, treated antimonial ores by fusing the sulphide with a proportion of metallic antimony, which, having a great affinity for gold, takes it up, and, on cooling, may be easily separated from the sulphide. The antimony is used until it has become rich in gold, when the two metals are separated by the oxidation of

the antimony. But this process is suitable only for ores rich in antimony. Mr. Cosmo Newbery, after long experimenting, has succeeded in discovering a process by which both the gold and the antimony in these poor ores can be saved. His method is to put the ore, as mined, into a close furnace, with some salt or other chloride, and heat it to dull redness; steam is then injected until the whole of the antimony is got rid of. The quartz or gangue is rendered extremely friable, the steam penetrating all parts of even the largest lumps that can be conveniently handled in charging the furnace. The chloride of antimony formed comes into contact with air on leaving the mass of ore, and is converted into oxide, the sulphuretted hydrogen being burnt at the same time; the oxide of antimony is collected in suitable condensers. When the charge is removed from the furnace, it is crushed, and the gold may be saved by amalgamation. The treatment of antimonial sands requires certain modifications. The steam is not easily introduced into a reverberatory furnace without admitting an excess of air, but a close furnace with automatic rakes may be used. The rakes, being perforated, and attached to the steam pipe, are used to distribute the steam in jets through the mass of sand.

Mr. Cosmo Newbery has gone yet further, and has devised in the laboratory a simple and inexpensive method for condensing the solidifiable portions of the fumes. It consists of a small flue, with an artificial draught, produced by a blower. The flue is contracted at intervals to a nozzle, which directs the fumes with force against a fixed plate. It is found that the solid particles adhere to this plate, forming a dense cone of such solidity that the strongest current of air fails to dislodge them.

From the practical results obtained in the treatment of the St. Arnaud (Victoria) ores, which contain, relatively to the gold, large quantities of lead, it would seem that by careful washing after amalgamation in pans, the loss to be feared from its contact with the mercury, may be so reduced as to be scarcely noticeable.

Zinc at a dull red heat alloys with gold, yet the alloy is easily amalgamated by mercury; it therefore requires no special notice.

There remains to consider two processes for the treatment of auriferous pyrites, viz.: Plattner's and Claudet's.

The former was proposed by Prof. Plattner more than 30 years ago, and has been used in Germany and America for many years; in some instances, successfully, in others, not. In Silesia (Germany), ores containing about 9 dwt. of gold per ton have been profitably treated by it; in California, also, it is considerably used. It consists in acting upon the pyrites—after roasting—by chlorine gas, obtained by the reaction of sulphuric acid with peroxide of manganese and salt. The gas forms a chloride of gold, which is dissolved out and precipitated, in the metallic state, by sulphate of iron, or as a sulphide by sulphuretted hydrogen. In theory, it is a simple process, and requires only a few hands; but in practice, there are several drawbacks. Pyrites, roasted and pulverised, fit for amalgamation, would not necessarily be fit for chlorination. Metallic iron must not be present, or it will precipitate the chloride of gold, and it is essential that all the particles of gold shall be as nearly as possible of the same size, as any large pieces will prolong the operation, and so cause waste of time and loss. In many countries, it cannot be used, as the chlorine-producing materials cannot be obtained sufficiently cheap.

With regard to Claudet's process, Mr. J. Arthur Phillips, the well-known metallurgist, who was associated with M. Claudet in carrying out his invention, assures me that it is quite unfitted to deal with ordinary auriferous pyrites, it being essentially a copper process, in which the gold is obtained as a bye-product at very small expense.

Oxidation.—The last point to which I shall refer is one which bids fair, if successful, to revolutionise the entire present treatment of pyritous ores. It is no less than oxidising them before crushing, thus saving the losses and expenses of concentration, roasting, and subsequent amalgamation. This, Mr. Cosmo Newbery has successfully accomplished in the laboratory, by a similar process to that I have just described as being used for the treatment of antimonial ores, viz., roasting in a close furnace with the introduction of steam. It remains to be seen whether the cost for fuel, labour, &c., will render the operation more profitable than the means now adopted.

Resume.

In this brief description of the processes followed in extracting gold from its natural combinations, I have endeavoured to introduce allusions to all the most important of the improper methods which have crept into use.

A cause of failure not yet noticed is the practice of burning the vein-stuff before crushing, with the object of lessening the wear and tear of the machinery, and increasing its effectiveness, by rendering the quartz very friable. If pyrites were entirely absent from the ore, the process might be valuable; but this is rarely or never the case. In simply roasting such large fragments of mineral, it is impossible to oxidise all the sulphur present in the pyrites. The result with common iron pyrites is that a lower sulphide is formed, which melts, and encloses fine particles of gold in a ferruginous glaze; while with arsenical pyrites, the arsenic set free in vapour may actually form an alloy with the gold. In either case, the gold is lost.

In conclusion, it may be interesting to illustrate the consequences of using suitable and unsuitable appliances, by a few examples of failure and success, quoted from official documents.

First, as to the failures. According to Mr. R. W. Raymond, there is no subject of "more importance to the mining interest of California than the economical treatment of gold-bearing ores, and it is a fact worthy of consideration that, after 20 years' experience in the business of quartz-mining, it is conceded that, with a few exceptions, from one-third to one-fourth of the assay value of the ores now being worked, amounting to several millions of dollars annually, passes off in the slimes, and is irretrievably lost."

In the case of an Australian mine, which was abandoned by the owners because they had no knowledge how to extract the gold from the pyrites,

assays showed gold varying from 19 dwt. 14 gr. to 1 oz. 6 dwt. 3 gr. a ton, besides silver, the total value being £4 3s. 6d. and £6 4s. 6d. a ton respectively; and a sample of what was considered poor tailings gave 9 dwt. 19 gr. of gold and over 25 ozs. of silver, the total value being £7 7s. 2d. a ton. A number of other samples of tailings, mostly non-pyritous. collected by the same official, gave the following proportions of gold per ton:—9 dwt. 19 grs., 12 dwt. 9 grs., 13 dwt. 17 grs., 16 dwt. 23 grs., 17 dwt. 15 grs., 1 oz. 0 dwt. 21 grs., 1 oz. 2 dwt. 22 grs., 1 oz. 6 dwt. 18 gr., 1 oz., 15 dwt. 22 grs. In New Zealand, too, no mining company has been able to pay a dividend from ore having less than 10 dwt. of gold per ton, a fact largely due "to positive loss of gold, which, with proper appliances, might have been prevented." The list might be extended indefinitely, but will suffice as an illustration. It shows the black side of the picture, and would represent gold-mining as a veritably undesirable and unremunerative undertaking; yet every one of these failures may be traced directly to a specific fault in the appliances used.

It is refreshing to turn to the other side, and see what has been effected by proper plans of treatment. And here I shall refer only to examples where the amount of gold obtained was less than the smallest amount thrown away in the previous case, which you will remember was 9 dwt. 9 gr. The first and most prominent example is the well-known Port Philip Co., of Victoria, to whose managing director, Mr. Rivett Bland, the science of gold-mining is much indebted. This company has to raise its ore from a depth of 700 to 1,000 ft. During the past 10 years, it has treated 600,531 tons, the average yield of which was 5 dwt. 13 gr., the extremes being 3 dwt. 23½ gr. in 1873, and 7 dwt. 21 gr. in 1878. The same company has treated 3,593 tons of pyrites, yielding an average of 4 oz. 3 dwt. 17 gr. of gold, when concentrated. The average total cost of treatment has been £3 13s. 7d. a ton; the average profit, £13 5s. Another Australian company, getting part of its ore from surface workings, has profitably crushed 283,550 tons, with an average yield of 2 dwt. 22 gr. Another treated 7,453 tons in seven months, with a return of 2 dwt. 10½ gr., and paid £2,101 10s. profit. Another realises a large profit from a yield of only 1 dwt. 14 gr. per ton of ore crushed. But the most remarkable of all is the Imperial Company, at Ballarat, which has treated 2,100 tons of quartz, affording only 21·99 gr. of gold per ton, with a fair margin of profit on the operation; in other words, it has made money out of material which is only one-tenth part as rich as the non-pyritous material which its neighbours are throwing away.

Of course, some allowance must be made for the character of the ore in different cases, and the general conditions surrounding the undertaking; but I do not think any doubt can now remain upon your minds that if the knowledge already acquired upon the subject of treating gold-bearing ores were judiciously and appropriately applied in all cases, we should soon see a satisfactory return for that sum of one million some odd thousand pounds, to which I referred at the beginning of this paper.

DISCUSSION.

The Chairman said as it was possible there might be some gentlemen present who would not be able to attend on Monday, he should be happy to hear any remarks any one might wish to make.

Mr. J. Valentine Smedley said he should like to express his appreciation of the paper and his thanks to Mr. Lock. He was not a mining engineer, nor qualified to give anything like a technical opinion upon the paper, but as a private individual he was very deeply interested in mining, in spite of himself. He had been connected with mining of various kinds during the last 20 years, as proprietor, as a shareholder in several mines, as director of several collieries, and as chairman, and, from having lost a good deal of money in mining he had endeavoured to abandon it, but in spite of his efforts, somehow or other, mining had stuck to him. At this particular period, when gold mining in India was so prominently before the investing public, Mr. Lock's paper was eminently opportune. The unfortunate experience he (Mr. Smedley) had had in gold mining led him to the conclusion that, whereas, as Mr. Lock had shown, they might be told what methods to avoid, and, on the other hand, what to adopt, he would go farther, and say that even in the case of proper methods and appliances, unless they were properly administered by the local managers or superintendents in charge, the great advantage of the improved methods was lost. It seemed to him that in almost every case the causes of failure had been nothing more nor less than local mismanagement of mines. He had not the number of dividend and non-dividend mines at his finger-ends, but he believed there were more of the latter than of the former; and he was one of those who thought that this was not owing to any want of precious metal in the mines, but because the mines were badly administered. Even in cases where proper treatment, such as suggested by Mr. Lock, had been present, the cause of failure was owing to those methods not being properly administered. He thought the time had come when a revolution must take place in the system of the management of mines.

Mr. Hepple Hall said he had not the same interest in gold mining as the previous speaker, but he had been a great deal in gold mining countries, and had seen a great deal of the various methods adopted. He came there expecting a great treat, and he had not been disappointed, but still he regretted that the paper had not a rather broader scope, for it seemed devoted principally to Australia, with some references to California. He had been in British Columbia and in Nova Scotia, where there was a great deal of gold mining, but this had not been touched upon in the paper. He would withhold any general remarks until the next meeting.

Mr. Fretwell asked if Mr. Lock had had any experience of gold mining in Hungary, especially in Transylvania, and if he could explain why these mines had not been profitable to the Government, who worked them.

The Chairman said Mr. Lock had had considerable experience of Hungarian gold mining, and he would, no doubt, deal with it fully in the discussion. He understood the object of the paper to be on the operations of gold mining, and how to obtain the last grain of gold from the quartz or matrix in which it was contained, but he did not understand that Mr. Lock confined himself to Australia or California. He took those countries as prominent instances of the treatment of gold by crushing, as distinguished from alluvial washing, or anything of that sort. As to the question of the management of gold mines, he hardly thought they could call on Mr. Lock to discriminate between well and ill-managed mines. He simply dealt with the method of treating the ores, with a view to obtaining the best results from them.

Mr. Morgan said he was interested in silver mining and silver extraction, and he should like to ask if Mr. Lock had turned his attention to the question of lixiviation. In the concern in America in which he was interested, the rebellious ores were absolutely useless up to a certain time, but by roasting and then treating in a wet way with hypo-sulphite of soda and hypo-sulphite of lime, the mines were now returning very large profits.

Mr. Lock said his object was to get the whole subject of gold mining thoroughly considered, and to get everybody to come forward who had something to say upon it. There was a vast outlet for capital in this direction if it were thoroughly understood, but, at the same time, opportunities of learning gold mining in England were wanting, so that the thing could not be properly worked. One gentleman had just mentioned one process, and if the whole subject were gone into and discussed by those who understood it, the discussion would be reported and get to the ears of others, and thus various people would be set thinking upon it, and it might result in the perfection of a new process. It was not fair, therefore, to the subject, to dismiss it in half-an-hour, when there were many anxious to take part in the discussion, who would have attended if the weather had not been so severe. For instance, there was Mr. J. Arthur Phillips, whose view of Claudet's process he had mentioned in the paper. That process was thought a good deal of in Australia, as one which would come largely into use in treating waste tailings, and Mr. Phillips could tell them more about it in five minutes than he could in a week. He should certainly not have given the account he had of it except with Mr. Phillips's express authority.

Mr. Smedley then moved that the discussion be adjourned to Monday evening.

Mr. Hall seconded the motion, which was carried unanimously, and the meeting adjourned.

CANTOR LECTURES.

SOME POINTS OF CONTACT BETWEEN THE SCIENTIFIC AND ARTISTIC ASPECTS OF POTTERY AND PORCELAIN.

By Prof. A. H. Church, M.A. Oxon., F.C.S.

LECTURE V.—DELIVERED DECEMBER 20, 1880.

Hard Porcelains, European and Oriental.

Whatever independent origins in diverse countries may be assigned to terra-cottas, earthenwares, and stonewares, there can be no question that from Chinese porcelain started all attempts to make true china or hard-paste porcelain. Early efforts in this direction failed, for one or other or all of three reasons—ignorance of the materials used in China, ignorance of their local sources, and ignorance of the composition of the paste, glaze, or colours. Difficulties in manipulation and firing there were indeed, but these proved but minor obstacles when knowledge of the materials* had once been secured. But let me not be misunderstood, for, if the energetic experimenters of the 17th and 18th centuries had succeeded in analysing Oriental porcelain into its constituents—so much silica, so much alumina, so much lime, and so much alkali—they would have been little or no nearer the desired success than before. The qualities or properties which distinguish hard-paste porcelain can be secured only by the association of certain previously formed compounds. Attempts to imitate the body, by heating the right proportion of the pure constituent oxides together to the right temperature, have ended in curious failure. Heat is obviously not the sole factor in the production of this remarkable material; its constituents must be already in some sort specially combined before firing, if they are to assume during that treatment the right condition.

* On this point, the letters of Père d'Entrecolles, 1712-22, constituted most important sources of information.

This seems to be the fitting place to introduce a few words about the minute physical or mechanical structure of hard porcelain. When a thin section is examined under the microscope, certain appearances are presented with a tolerable approach to constancy. We may classify these physical constituents of hard porcelain thus:—

1. Clear paste, the binding material.
2. Opaque rods, called belonites, variously dispersed and associated.
3. Minute granules, calledspherulites.
4. Quartz or other unchanged mineral fragments.
5. Spherical bubbles.

It is very common to find three layers in Oriental porcelain (*a*) body; (*b*) wash, slip, or coating; (*c*) glaze. The wash (*b*) is put on as a convenient ground for bringing out the colours: it is usually highly aluminous, and so, while free from quartz grains and bubbles, is generally rich in belonites. These straight-ended, opaque rods, are associated in ferruginous porcelains with curious dendritic growths, in which silica is combined with oxide of iron and with lime, as well as with alumina.

Before entering into details as to the artistic elements of Oriental and European hard-paste porcelains, it will be serviceable if I present to you a series of analyses, some already published, and some new, of porcelain bodies and porcelain clays. On the older analyses implicit reliance cannot be placed. Methods of separation and estimation were imperfect, and the recognition of magnesia, potash, and soda, was frequently most confused. I begin by drawing your attention to a few of these older analyses of Chinese porcelain:—

	1st Quality.	2nd Quality.	White vase.
Silica	69·0	73·3	70·5
Alumina	23·5	19·3	20·7
Oxide of iron	1·2	2·0	·1
Lime	·3	·6	trace.
Potash	3·3	2·5	6·0
Soda	2·9	2·9	trace.

	Dish.	1st Quality.	Inf. Quality.
Silica	73·5	71·0	69·0
Alumina	18·5	22·5	29·2
Oxide of iron	·1	1·0	1·6
Lime	trace.	(?)	(?)
Potash	5·0	1·2	(?)
Soda	(?)	(?)	(?)

I give for comparison with these figures some analyses I have made of specimens of ancient Chinese porcelain found in a ruined Indian temple:—

	a. White body.	b. Brownish body.	c. Glaze of a.
Silica	75·0	72·0	67·5
Alumina	17·8	17·5	14·5
Oxide of iron	·2	2·5	2·5
Lime	1·0	1·5	10·0
Potash	4·5	5·0	4·0
Soda	1·0	1·0	·5
Magnesia	·5	·5	1·0

On looking through these analyses of Chinese porcelain, you will see that the per-centage of silica averages over 71, while that of alumina corresponds to a mean of about 21. Let us keep these figures in mind when we are examining the composition of hard European porcelains. We may here note also the general preponderance of potash over soda amongst the alkaline constituents of the body; also the remarkable richness in lime of the single example of glaze analysed.

Turning to Japanese porcelain (the manufacture of which probably began about A.D. 1513), I have to offer you these two analyses by Mr. H. Würtz:—

	Eggshell, Sp. Gr. 2·337.	Thick, Sp. Gr. 2·308.
Silica	78·8	74·5
Alumina	17·8	19·3
Oxide of iron	·6	1·9
Lime	·2	·1
Potash	·2	·6
Soda	2·0	2·8
Magnesia	trace	·2

In these analyses, the chief feature shown is the marked higher proportion of soda over potash, a contrast to the relative per-centage of these alkalies in Chinese porcelains. A detail in the manipulation of Japanese porcelain may be mentioned now, namely, the slight firing which the ware receives in the biscuit state previous to the application of underglaze colours and of the glaze; but a high temperature is used afterwards.

We are gradually accumulating a full series of careful analyses of Japanese clays, thanks to H. Würtz, Professor Atkinson, and two other chemists. Henry Würtz found in his examination of Arita clays that the silica oscillated between 74·5 and 82·3, the alumina between 14·0 and 19·3 per cent. In his tenth analysis the silica was 50, and the alumina as high as 38·7—figures under those demanded by normal kaolin.

Atkinson's analyses of Japanese clays gave—

		Silica.	Alumina.
Satsuma	1	60·7	22·7
,,	2	73·1	20·2
,,	3	59·4	27·9
,,	4	77·2	13·5
,,	5	51·8	30·9
,,	6	60·3	27·6
Takayama	1	81·9	11·8
,,	2	72·0	15·7
,,	3	70·8	17·8
Banko	1	64·7	22·6
,,	2	60·2	23·3
Owari		54·6	32·4
Kôfu		59·1	26·1
Kiyoto		56·9	28·6

None of these, it will be noticed, is very near the composition of our European china clays, and some are far removed from it.

Before speaking of the artistic elements of either Chinese or Japanese porcelain, as illustrated by the specimens on the table, I purpose drawing your attention to that remarkably active period for the European production of hard porcelain, namely, the first half of the 18th century. About the close of the third quarter of the preceding century, Dwight, of Fulham, succeeded in attaining a measure of success, although he had clearly not got hold of the true china clay. But about 35 years afterwards, Bötticher, at Meissen, under the patronage of Augustus II., Elector of Saxony, and King of Poland, first realised in Europe the production of true hard porcelain, equal, if not superior to that of China. It was his knowledge of the proper clay, "Schnorrische weisse Erde," as it is called, found near Aue, Schneeberg, Erzegeberge, which enabled Bötticher to secure success. A chronological list of some of the more important hard porcelain factories, started during the 18th century, presents many features of interest: especially, did time permit, could I show you how the knowledge of the needful materials or ingredients, and where to find them, gradually spread from works to works, generally by workmen who had been discharged, or bribed, had managed to run away with the secret. Thus Vienna got its information from Meissen, Höchst from Vienna, and Berlin from Höchst.

1709. Bötticher, at Meissen.
1718. Stolzel, at Vienna.
1718. Anspach.
1720. Bayreuth.
1740. Ringler, at Höchst.
1744. St. Petersburgh.
1747. Neudeck.
1750. Wegeley, at Berlin.
1753. Baden.
1758. Ludwigsberg, Nymphenberg, and Fulda.
1764. Brancas-Lauraguais at Sèvres.
1768. W. Cookworthy, at Plymouth.

Besides all these manufactories of hard paste, many others were established in Germany, France, Switzerland, and Holland, towards the close of the last century.

It will be of interest if I now present you with some analyses of European hard porcelains. We shall be able to discern the chemical differences which sever them from oriental wares; and we shall see that these differences, if they do nothing more, at least give us the means of overthrowing such an egregious fancy as that which has attributed to Lowestoft, in Suffolk, the manufacture of tens of thousands of pieces of inferior Chinese porcelain. Analysis shows at once the absolute identity of duly authenticated pieces of hard Lowestoft, with similar pieces known to have been made in China.

Beginning with Dwight's semi-porcelain made at Fulham, a fragment of an authentic specimen from the Reynolds "collection" gave the following numbers, clearly showing that Dwight had not introduced kaolin into his ware:—

	Per cent.
Silica	79·5
Alumina	12·5
Oxide of iron	1·0
Lime	1·5
Potash	3·0
Soda	1·5

I now give a series of analyses representing the composition of many Continental porcelains :—

	Berlin (1836.)	Berlin.	Meissen (1825.)
Silica	66·6	71·3	57·7
Alumina	28·0	23·7	36·0
Oxide of iron	·7	1·7	·8
Lime	·3	·6	·3
Potash	3·4	2·0	5·2
Soda	(?)	·6	(?)

	Bohemia.	Nymphenburg.	Vienna (1806).
Silica	74·8	72·8	61·5
Alumina	21·1	18·4	31·6
Oxide of iron	(?)	2·5	·8
Lime	·6	3·3	1·8
Potash	2·5	·6	2·2
Soda	·6	1·8	—
Magnesia	—	—	1·4

Since the time when hard paste almost, if not quite, completely displaced *pâte tendre* at Sèvres, the composition both of the body and the glaze there has remained constant, except for special purposes. The body is so made up, after analysing the ingredients, as to contain, per 100 parts :—Silica, 58; alumina, 34; lime, 4·5; potash, 3·; magnesia and soda, ·5. In order to secure this composition, 73 of kaolin, 24 of felspathic sand, and 3 of lime, were used in 1839. In 1843, the percentages taken of these three ingredients were respectively 48, 48, and 4. The Sèvres glaze is now obtained with the china-stone of St. Yrieix. Its composition may be gathered from these partial analyses :—

	1826.		1839.		1841.
Silica	73·0	..	73·4	..	74·3
Alumina	16·2	..	15·7	..	18·3
Potash	8·4	..	7·4	..	6·5

It will be remembered that the ascendancy of hard paste at Sèvres dates from 1768. Efforts by the royal factory to buy the secret of kaolin from foreigners had failed, when, as the story goes, Madame Darnet, wife of a surgeon, of St. Yrieix la Perche, found a white clay for cleaning linen in a neighbouring ravine. M. Darnet showed this to M. Villaris, a druggist, of Bordeaux, who recognised in it the long-desired kaolin. He sent the substance to M. Macquer, the chemist of Sèvres, who obtained an identical substance at St. Yrieix in August, 1765, and in June, 1769, read a memoir, illustrated with specimens, on "Porcelaine dure Française."

A peculiar interest is attached to the excessively rare porcelain made by the Comte de Brancas-Lauraguais. He began, about 1758, discovering the kaolin of Alençon. He worked at Sèvres, and probably also at Chelsea. He was acquainted with the china clay and china stone resources of Cornwall. His English patent, for hard or true china, was taken out in June, 1766, but his invention was never specified. He thus anticipated W. Cookworthy's patent by two years. Brancas-Lauraguais and his porcelain are named in the *Scot's Magazine* for 1764, by Dr. Erasmus Darwin, in a letter to Josiah Wedgwood; and by the Abbé Raynal. Horace Walpole possessed a porcelain reproduction, by the Count, of the Bacchus of Michel Angelo. In M. Gasnault's collection there is a medallion dated "Octobre, 1764." The Rouen Museum possesses a specimen bearing the date Septembre, 1768. The Musée Ceramique at Sèvres has no less than three pieces of Brancas-Lauraguais porcelain. M. Jules Vallet has a plate with coloured decoration in an Oriental style. The late M. Jacquemart owned a cup. There were three specimens in the Alexandra Palace: these were destroyed in the disastrous fire of June, 1873. One of these last-named pieces was a tea-bottle or tea-poy; its decoration of flowers reminded me forcibly of that of Chelsea, period 2; the paste was fine, hard, and of good colour; altogether this specimen showed to what a degree of perfection the Count had brought his invention. I made an analysis of a fragment of a twisted column of this porcelain, with the following results :—

	In 100 parts.	
Silica	58	Spec. grav. 2·531.
Alumina	36	
Oxide of iron	1	
Lime	1	
Potash	3	
Soda	1	

The kaolinic character of this ware is evident.

I have to direct your attention now to the only manufactory of hard paste porcelain in England, which attained any considerable degree of success. We may call it, perhaps, "Plymouth—Bristol." A company was started in Bristol, as early as 1765, for making china from Cornish materials; the Plymouth factory began in 1768. Richard Champion added the latter to his own Bristol works in 1773, continuing the manufacture until 1781. No doubt W. Cookworthy had discovered china clay long prior to the earliest of these dates; but ceramic chronicles constantly show that the interval between china clay and china may be a very wide one.

An analysis of Champion's Bristol porcelain gave me—

Silica	63·0
Alumina	30·0
Lime	1·3
Potash and soda	2·5

Cookworthy mentions that the kaolin of St. Stephen's burns, to a degree of transparency, even without the addition of china stone; but the above analysis indicates, as we should expect, that china stone was a normal ingredient of Bristol porcelain. Cookworthy used, for glaze, "stones having green spots, from Tregonnin-hill." And when he wanted a more fusible mixture, he took—1 part of lime, and 2 of fern-ashes, to 30, 45, or 60 of the above china stone. Kaolin, pipe-clay, and sand were used as safeguards in the kiln.

It will be useful if I now give you a few facts about kaolin, although time forbids my entering into full details concerning this substance. Were kaolin always completely formed, and always derived from the decomposition of the same mineral, it would exhibit a greater constancy of composition and properties than is the case. From some clays, it is true, a substance of apparently specific mineral rank has been isolated, and is known as kaolinite. But if a substance of this definite sort

be a common constituent (often the chief constituent) of china clays, yet the existence of aluminous silicates of different composition, but nevertheless adapted for porcelain-making seems proved by the analyses of many of the Oriental clays used in this manufacture; and it must be borne in mind that china clay proper, or kaolinite, as it occurs in nature, is never free from traces at least of iron, lime, magnesia, potash, and soda, none of which enter into its formula, but are proofs of the incompleteness of the process by which it has been formed. Indeed, these accidental constituents may reach a sum of five per cent. of the total weight of the kaolin. Kaolinite, it should be stated, is assumed to possess the following per-centage composition:—Silica, 46·3; alumina, 39·8; water, 13·9. The greater part of the water needs a temperature above 212° F. to expel it.

I would now direct your attention to the individual specimens of hard-paste porcelain on the table. But a few words seem necessary concerning certain highly felspathic bodies which come so near true hard china, that they may well be mentioned now. The most notable of these is that employed by L. Solon for the decoration of his celebrated *pâte sur pâte* pieces. Thanks to Messrs. Minton, I am able to show you four specimens of this most refined and lovely work. It is marvellous to see Mr. Solon, as I have been privileged to see him, without outlines or previous sketching, laying the wet porcellanous slip with a brush on the coloured ware in the green state, and then carving the powdery substance into forms of exquisite truth and tenderness. If you examine this specimen of this artist's work, this pilgrims' bottle, you will, I trust, agree with me that the glaze, which has yet to be applied, will be very far from improving the artistic qualities of the surface, the form, the colour, and the design of the piece generally. But the manufacturers have their own reasons for covering fine work with glaze; and the porcelain purchasers, for the most part, have no objection to the glazing layer which, if it protects, yet conceals and even modifies the body and its decoration. Some day, let us hope, a surface like that of Wedgwood's finest jasper will permit Solon's exquisite work to be thoroughly enjoyed.

I have here some tiles and a jug, which under the name of "crystal porcelain," have been lent to me this evening. It is a hard, apparently felspathic material, resembling Wedgwood's jasper bodies, somewhat closely in appearance, and in the quality of receiving coloured oxides into intimate union with its mass. From these examples I judge that good use may be made of this material for painting those designs in which softness and richness are desirable without having recourse to glazing.

[The lecturer concluded by noticing the chemical and physical characteristics, so far as they threw light upon the decorative qualities, of a large number of specimens of Continental and English hard-paste porcelains, chiefly contributed by Mr. Litchfield. He then examined and explained from the same standpoint—crackle porcelain, blue underglaze, Chinese porcelain with black, coloured, and mottled glazes, noticing especially the céladon, turquoise, ruby, and opaque canary and mustard yellow colours. He showed how a pure good cobalt blue is revealed by means of the light from burning magnesium. He spoke also of the various kinds of Oriental white or uncoloured porcelain, and of the methods of decorating it by incised work in the paste. The fertility and skill of the Chinese, as shown in their splashed, mottled, and sprinkled glazes, was touched upon.]

MISCELLANEOUS.

CITY OF LONDON COLLEGE.

The prizes and certificates gained by the students at the annual examinations of the City of London College, the Society of Arts, and the Government Department of Science and Art, were distributed on the 4th of January, at the College, in Leadenhall-street, by the Right Hon. A. J. Mundella, M.P., the Lord Mayor being also present. Having distributed the prizes,

Mr. Mundella first directed his remarks to the students, and then addressing the Lord Mayor, observed that it was a matter of great rejoicing to him that the Corporation of the City of London had, during the past few months, made a step in the right direction. They had voted £10,000 towards the new technical guilds to be established at South Kensington, and £2,000 a year for some years, and he saw that the great City guilds, whose names were identified with our British industries, and which had presided over their infancy, but had long ceased to have any connection with them but their name, had recently taken it in hand to improve the skill, industry, and force of the British workman. He, however, thought it was only right to say that the sum which had been raised, £50,000 for building, and £5,000 for sustenance, was altogether inadequate, and if the City of London and the guilds of London were to do anything worthy of their name and position, they must do far more. The sum mentioned was not sufficient for the sustenance of the laboratory. A single institution in a German town had spent £60,000 on the laboratory added to it last year. He knew second and third rate towns spread over the continent of Europe which had spent in the last four or five years double the sum which was supposed to be sufficient to represent the great City of London. The Corporation could do no better work than affiliate this institution to their new college. Mr. Mundella then pointed out what great manufacturers had done for technical instruction in Sheffield, in Leeds, in Dundee, and in Birmingham, and alluded to the noble works done in Manchester and Liverpool; and he urged the merchants of London to follow the example of local towns, and immediately provide a suitable home for the college as good as what the small town of Keighley, in Yorkshire, had done for its locality.

Sir Henry Cole, in responding for thanks to the Society of Arts, which had helped to give the college its present name in 1853, showed how much the Society had acted as the pioneer of all the existing examinations. Now the great growth of public education had left the Society to examine only in Political Economy and Domestic Economy and Music. To discuss Domestic Economy in education, and show how much it was women's especial work rather than men's, a congress would be held in the summer, when distinguished ladies would be the chief workers at the congress. He congratulated Mr. Mundella on his public declarations to decentralise public education.

Before the meeting ended, the **Lord Mayor** stated that he would summon a meeting in the City to advocate the claims of the college to have a suitable building, and Mr. Mundella promised to attend it.

ST. GOTHARD RAILWAY.

An account of the Leggestein spiral tunnel, which is one of the most remarkable works in connection with the St. Gothard Railway, has been communicated to the *Daily News* by the Geneva correspondent of that paper.

"The leading feature of the scheme adopted by the engineers in constructing the line has been to keep to the bottom of the valleys—on the north side of the Alps, the valley of the Reuss; on the south side, that of Ticino—and, so long as they did not deviate too widely from the required direction, to follow their windings until the point fixed for the entrance of the great tunnel should be reached. When this could not be done, and it became necessary to carry the railroad higher, spiral, or to use the German term, 'turn tunnels,' were to be pierced through the mountains. These tunnels made at once a steep gradient and a sharp curve. The gradient of the Leggestein tunnel is 23 in the 1,000, and it describes a curve of 300 metres. After leaving it, the line winds spirally outside the mountain, and passing through a shorter passage higher up, reaches the required altitude. The construction of this tunnel was difficult, less on account of its length, which is nothing extraordinary, than owing to the necessity of boring entirely by hand through a mass of almost impenetrable granite. The progress made at the outset did not exceed three décimètres (twelve inches) in twenty-four hours, even with the aid of blasting. The necessity of handwork arose from the absence of water, and the impossibility, in the circumstances, of using steam for the perforators. Two other turn tunnels—in the valley of the Reuss that of Wellington, 1,000 mètres long, and that of Pfaffensburg, 1,000 mètres long—will be completed during the coming spring. The former, like the Leggestein, is being bored by hand, the latter by water power. On the south side, in the valley of the Ticino, there are four tunnels (which are to alpine railways what locks are to canals), of from 1,500 to 1,600 mètres long, now in course of construction. All these are being bored by water power, and like those on the north side are expected to be finished early in 1881. It is intended to light the great tunnel by electricity. To this end two systems have been proposed. One is to place in the passage 40 electric lamps, each possessing a capacity of 1,200 candles. The interval between each lamp would be about 400 yards, and the necessary motive power would be supplied by the turbines at Airolo and Goeschenen, which have been used for moving the perforators and ventilating the workings. The second proposal, whether it be practicable or not, has certainly the merit of greater originality. According to this scheme, a locomotive impelled by compressed air would be stationed at either portal of the tunnel. These locomotives, being smokeless, would be used for drawing the trains through the tunnel. Each locomotive would carry two electric lamps, and two would be placed at the end of the train, together with reflectors, so arranged that their united light would be equal to that of 12,000 candles. By this means, wherever there was a train, and for a considerable distance before and behind it, the tunnel would be brilliantly lighted at a comparatively trifling expense, the electricity being produced and the engines provided with their motive power by the turbines at Greschenen and Airolo."

CORRESPONDENCE.

BREAD REFORM.

Dr. J. H. Gilbert, F.R.S., writes to the Secretary of the Society regretting his inability, on account of pressure of other work, to read a paper at the Society of Arts during this present Session, and goes on to say, "If I had any spare time for such a purpose, I should be disposed to discuss the important food question of the so-called bread reform. Many years ago Mr. Lawes and myself went somewhat fully into some of the points involved (*Journal of the Chemical Society*, vol. x., 1857). We showed the distribution of the nitrogen, the total mineral matter, the phosphoric acid, &c., in the different mill products from wheat grain. It is true that about three-fourths only of the total nitrogen of the grain are found in ordinary bread-flour, the remaining one-fourth or so being retained in the usually excluded portions, which latter are richer in nitrogen than the flour. But it has long been known that a considerable part of the nitrogenous matters of the excluded portions is not in the same condition as those in the flour; and it is stated that they are in an inferior degree digestible and available. Recent investigations show that only from two-thirds to three-fourths exist in the albuminoid condition; and it is as yet not settled whether, or in what degree, the non-albuminoid nitrogenous bodies are of nutritive value. So far as they are not, the value of the excluded portions will be proportionately reduced (so far as this is dependent on the nitrogenous compounds), and it may be even lower instead of higher, for a given weight, than in the flour. Of the phosphoric acid of the grain, it may be said that not more than about one-third will be found in the bread-flour. And, although I am not aware that the point has been proved, it may be that the flour is in a greater degree deficient in a due proportion of phosphoric acid than of nutritive nitrogenous compounds; and, if this be the case, it is a question whether it would not be better to add phosphoric acid in the process of bread-making (as is sometimes done in America), than to include the whole of the more phosphatic portions of the grain. For, if these were supplied in a coarsely-ground state, there would be waste of food by its passage through the body unused; and, if so finely ground as to avoid the aperient action, it is a question whether evil would not then arise from the excess of earthy (and especially magnesia) phosphate, causing accumulation and concretion. Indeed, notwithstanding the exclusion of so much of the nitrogen and phosphoric acid of the grain from ordinary bread-flour, we nevertheless came to the conclusion that such flour was better food than whole-meal bread, for the reasons that the nitrogenous matters of the excluded portions were of lower nutritive value; that those portions contained a considerable amount of indigestible woody matter; and that the branny particles so increased the peristaltic action as to cause the passage from the body of a large amount of the food unused. In reference to the points which are now again brought so prominently forward, we said, in the paper above referred to (pp. 33, 34):—

"'The higher per-centage of nitrogen in bran than in fine flour has frequently led to the recommendation of the coarser breads as more nutritious than the finer. We have already seen that the more branny portions of the grain also contain a much larger per-centage of mineral matter. . . . . It is, however, we think, very questionable whether, upon such data alone, a valid opinion can be formed of the comparative values, as food, of bread made from the finer or coarser flours from one and the same grain. . . . . Again, it is an indisputable fact that branny particles, when admitted into the flour in the degree of imperfect division in which our ordinary milling processes leave them, very considerably increase the peristaltic action, and hence the alimentary canal is cleared much more rapidly of its contents. It is also well known that the poorer classes almost invariably prefer the whiter bread; and among some of them who work the hardest, and who, consequently, would soonest appreciate a difference in nutritive quality (navvies for example), it is distinctly stated that their preference for the whiter bread is founded on the fact

that the browner passes through them too rapidly, consequently before their systems have extracted from it as much nutritious matter as it ought to yield them. It is freely granted that much useful nutritious matter is, in the first instance, lost as human food, in the abandonment of 15 to 20 per cent. of our wheat-grain to the lower animals. It should be remembered, however, that the amount of food so applied is by no means entirely wasted. And further, we think it more than doubtful, even admitting that an increased proportion of mineral and nitrogenous constituents would be an advantage, whether, unless the branny particles could be either excluded, or so reduced as to prevent the clearing action above alluded to, more nutriment would not be lost to the system by this action than would be gained by the introduction into the body, coincidentally with it, of a larger actual amount of supposed nutritious matters. In fact, all experience tends to show that the state, as well as the chemical composition of our food, must be considered; in other words, that its digestibility, and aptitude for assimilation, are not less important qualities than its ultimate composition.'

"Of course, if the branny portions were reduced to a perfect state of fineness, and it were found that this prevented the aperient action, and that other evils were not induced, or, better still, if more of the food material can be separated from the bran, and in either case without more cost than the saving would be worth, there might be some advantage. But, to suppose that whole wheat meal, as ordinarily prepared, is, as has generally been assumed, weight for weight, more nutritious than ordinary bread-flour, is an utter fallacy, founded on theoretical text-book dicta; not only entirely unsupported by experience, but inconsistent with it. In fact, it is just the poorer fed and the harder working that should have the ordinary flour bread rather than the whole-meal bread as hitherto prepared, and it is the over-fed and the sedentary that should have such whole-meal bread. Lastly, if the whole grain were finely ground, it is by no means certain that the percentage of really nutritive nitrogenous matters would be higher than in ordinary bread-flour, and it is quite a question whether the excess of earthy phosphates would not then be injurious."

Dr. Gilbert adds that Mr. J. B. Lawes concurs with him in the opinions stated.

EDUCATION CODE REFORM PROSPECTS.

I wish, as a member of the Society, to call attention to the prospect of extensive changes in the principles of the present code, which is unintelligible except to technical experts, like the Education Inspectors and staff at Whitehall, and not very clear to them. I send extracts from speeches recently made by Mr. Mundella, the Vice-President, who is reported, on the 1st December, 1880, to have said at Huddersfield, "As Vice-President of the Council, he was not disposed to treat local authorities as if they were children in leading strings. He wished School Boards to be responsible rather more to the ratepayers and rather less to the Education Department." On the 15th December, 1880, Mr. Mundella said, at Sheffield, "What he wished was to place more responsibility upon the locality and less upon the Education Department;" and on the 29th December, 1880, he said, at the Borough-road College of the British and Foreign School Society, "He and all educators desired for the teachers the greatest possible freedom in their teaching, to free them from all unnecessary routine." The receipts to the 31st August, 1879, given in the Annual Report, were as follows:—"The schools obtained £136,078 by endowment, £636,792 from rates, £754,133 by voluntary contributions, £1,349,297 by school pence, and £23,066 paid by Guardians of the Poor, making a total of £2,899,366. The Government grant was £1,828,702; all these sums, with £48,841 from other sources, making a total of £4,776,914. Of this the local contributions amounted to £2,948,207, whilst the Government grants were only £1,828,707." Thus it appears that the local funds spent on elementary education were upwards of £1,100,000 more than the Government grant. If Mr. Mundella's excellent intentions are fulfilled, it may be hoped that the present "leading strings" imposed on local authorities will be relaxed in due proportion.

F. S.

SIGNALLING BY MEANS OF SOUND.

I was not present when the paper by Mr. Price Edwards, on signalling by means of sound, was read, on the 15th ult., but I have read with interest the report in your *Journal*, and, if permitted, should like to offer a few remarks upon it.

Mr. Price Edwards approves a system of sound signals based on distinctions obtained by making blasts to occur in groups of one, two, three, or four blasts at a time, with varying intervals of half a minute, one, two, or three minutes between the groups of blasts. Sixteen distinct signals are thus obtained.

In the discussion which followed the paper, Mr. Preece supported the proposal made by Sir William Thomson to use a system based on that of telegraphy, using long and short sounds, as in the Morse system, but no one present at the meeting seems to have mentioned the plain numerical system of signals proposed in 1851 by my father, the late Charles Babbage, applicable both to light and sound. It was published in 1851, and was communicated to the Trinity House in November of that year. It was reported on by the Lighthouse Commission of the United States, whose report was printed and published in 1852.

By that system every lighthouse in the world would have its own number, which would be continually repeated, either by light or sound, as long as necessary. Thus, if the lighthouse was numbered 73, there would be during foggy weather seven blasts at short intervals, then a pause; then three blasts, and a longer pause; after which, the same would be repeated as long as the fog lasted. The number of the lighthouse could thus be repeated in less than 30 seconds, and as the lighthouses on either side would be arranged with numbers not having the same digits (say, for example, 25 and 48), the counting of *one* digit would in most cases indicate the lighthouse, and the counting of the *second* would afford a check, and give positive assurance of the correctness of the observation, if it was found to tally with the number found on the chart. In this system nothing else has to be done beyond counting the number of the blasts; no previous knowledge whatever is requisite, and a glance at the chart tells everything wanted; surely this is within the intellect of almost any sailor of any nation able to use a chart.

Now, contrast this with the other two systems. In the Morse system, the sailor must observe, not only the length of each and every blast, but he must also watch the sequence of the long and short blasts, and he must know the combinations of them which represent each numeral, before he can be sure of the number of the lighthouse before him, and find it on his chart. It is true that the Morse spstem is used for the heliograph and army signalling, and also in the Royal Navy for night signalling, but I believe that a specially instructed staff is required in all cases to work it, and that by all others it is found quite impracticable.

In the Trinity House system also, not only must the number of the blasts be counted, but the interval between each group must be measured, and how often would mistakes be made in this during the anxious

moments of danger, when, at any instant, the ship might strike and go to the bottom. Then, supposing the observation correctly made, the mariner would have to search on his chart, not for a simple number alone, but for the comparatively complex characteristics which he has observed, and which would not meet his eye so readily as a simple number; perhaps, if a foreigner, he might not be able to read it at all. Besides these very serious defects, the Trinity House system provides only sixteen signals, of which four only are repeated within the half-minute, and four of them require as much as three minutes; but, in these days of steam, what might not happen from ignorance of the identity of the lighthouse for three, two, or even one minute! Then, again, unless the number of the lighthouse was different for light and for sound (which would be very unadvisable), restricting the number to sixteen for fog signals, would similarly restrict it for light also.

It seems to me that the simple numerical system has advantages over every other yet proposed, and it is capable of being gradually introduced. Until it has been fairly tried, it should not be rejected by the Trinity House. The expense of setting up one, say somewhere towards the mouth of the Thames, where many could see and hear it, would not be thrown away.

Henry P. Babbage.

Bromley, Kent.

SANITARY INSPECTION.

There are one or two points in Professor Fleeming Jenkin's paper and the discussion upon "A Sanitary Protection Association for London," about which I should like to make a few remarks. The most serious objection to the whole scheme is that, on the face of it, the first expense, namely, the small subscription, is but the prelude to heavier outlay, and that the great majority of persons, whose means would necessitate their taking advantage of the association, could not afford to carry out the works which would be recommended, even if they had a sufficient interest in the property they occupy to justify the expenditure. These would only be dissatisfied with their houses without reasonable opportunity of putting right the imperfections revealed to them, and, in most cases, it would be better for them never to have had a question raised. When anything is radically wrong, the proposed inspection by the association would only lead to the employment of other professional assistance, and no saving would be effected. Again, professors of sanitary matters are so utterly at variance upon what they individually consider to be vital questions, that the public could not place anything like implicit reliance upon the reports furnished them, and would more often than not find those called in to remedy alleged evils disagree altogether with the advice given by the official of the association. Further, there is the difficulty to be encountered with local Boards and Vestries, who often will not sanction what might be considered, from a sanitary point of view, the best modes of dealing with drainage. To illustrate this, I may mention that I am one of those dreadful persons who let land to suburban builders of the speculating class for the erection of small dwellings. Nevertheless, in all cases in which it is reasonably practicable, I should like even these buildings to be constructed on sanitary principles; and with regard to one parcel of ground, my common-sense led me to the opinion stated by Mr. Rawlinson, that "when houses were dealt with as they ought to be, there would be no drain-pipes within them." This piece of ground is surrounded on three sides by roads, in which there is no sewer. This necessitates the construction of a sewer through the middle of the ground, and my desire was to drain all the houses into this through their gardens, and so that no drain-pipes should run under any house. The local authorities, however, would not allow me to do so, and insisted on the usual drainage through the houses, with regard to those fronting roads having sewers. Consequently, in a row of houses which might have all been drained from the back without any pipes under the house, every alternate house has its drain (carrying its sewerage and that of the adjoining house), running underneath the parlours, with the danger at any time of breakage, and the escape of noxious gases, and the unpleasant necessity, in case of stoppage of the pipes, of opening up the drain inside the house. There may be some power by which I could have insisted upon permission being given to drain in the proper way, but it would not have done for me to have exercised it, it being so impolitic to go against local authorities.

I notice, too, that one of the speakers "had felt strongly for many years the helpless condition in which tenants were placed with regard to these matters." This is to some extent true, though looking at the great number of unlet houses they have to choose from, it is only partially so. But the fact is that the ordinary run of tenants do not care, and will not pay for properly constructed houses. A hideous burlesque of grand style of architecture, applied to £30 a year houses, will often let them readily, though inside they may be, but "whited sepulchres." Hundreds of sensibly-built houses stand empty because "they are not pretty enough." Again, the honest builder who spends, say £300 to £320 in building a £30 a year house, gets only the same rent as the jerry builder, who has constructed houses, similar in appearance, at about two-thirds of that cost. The real remedy for the present wretched system of building is a revival of the custom, which I have heard used to obtain in town, and largely exists still in country places, of persons having houses built for them, instead of buying and renting ready-built houses. The question of cost would then be more fairly adjustable to the value obtained.

Finally, let us insist upon cleanliness and sanitation with such means as are at hand. Let closets and sinks be frequently flushed and windows opened. In short, let the elementary principles of domestic management, now happily being taught to the poorest children in our Board schools, be practically applied. In the meantime, let professors of sanitation and patentees of sanitary appliances (many of which, let us honestly admit, are good and valuable; but many more of which are absurd and worthless) fight out their wordy strife as they will, and perhaps, even they some day may come to agree upon what are the "principles of sanitation"—principles which, up to now, I have vainly endeavoured to glean from either their lips or their pens.

Jas. Ball.

East Dulwich, 17th January, 1881.

NOTES ON BOOKS.

Association Internationale pour l'Eau Potable. Séance Générale tenue à Turin le Jeudi, 9 Septembre, 1880, à l'Occasion du Troisième Congrès International d'Hygiène. Amsterdam, 1880.

This volume consists of the address of the President, Mr. J. G. Jäger, and the report of the proceedings of the meeting held on the 9th of September. The association grew out of the work of the International Congress of Hygiene, and was formed in Holland with the object of finding an answer to the question put by King William III. to his ministers at the period of the cholera epidemic of 1866. The question of the King was to this effect—whether the quality of drinking water has any influence over the spread of cholera, and, that influence being admitted, whether the State should intervene, or whether the matter should be left to the care of

local authorities. After considerable discussion, the meeting unanimously passed a resolution, affirming that it was necessary for the Central Government to intervene in order that the good quality of drinking water should be assured. Mr. Jäger specially alluded to the Report of the Select Committee on the Water Supply of London, the account of which he quoted from the *Journal of the Society of Arts.*

Designs and Catalogue of Cabinet and Upholstery Furniture, Looking-glasses, &c. London: C. and R. Light, Curtain-road, 1880.

This large folio volume contains one thousand nine hundred and eighty designs for articles of furniture in a great variety of styles, which are arranged under the headings of hall, library, dining room and parlour, drawing-room, bedroom, camp and ship, kitchen, and garden. The information given in this book is so arranged as to be practically useful to those who require designs for furniture, such as are called for by the wants of the present day. Prefixed are some "Notes on Household Furniture," which contain a slight sketch of the changes that have taken place in the fashion of British furniture from the time of the Saxons, when little more was found necessary than a series of benches and a heavy table upon which the dwellers in the house and the guests slept at night, down to the present time when furniture described as Early English, Mediæval Gothic, Renaissance, Italian, Venetian, Louis XIV., Louis XVI., Queen Anne, Chippendale, Neo-Greek, and Japanese, all find their different admirers. Special mention is made of Sir William Chambers, the architect, Thomas Chippendale and Thomas Sheraton, the cabinet-makers, and Thomas Hope, the connoisseur, whose works greatly influenced the fashion of domestic furniture in England. Chippendale's "Gentleman and Cabinet-maker's Director" was published in the year 1759, and appears to have suffered from some adverse criticism. The majority of the designs are of that pure and rather severe style which is associated with his name, but there are also specimens of florid ornamentation in the debased French taste adapted to frames and cornices which curiously enough are now often referred to as distinctive Chippendale work. Sheraton's "Cabinet-maker and Upholsterers' Drawing Book" appeared in 1793, the first volume being devoted to the science, and the second to the art of the cabinet-maker's trade. Mr. Hope's volume, entitled "Household Furniture and Interior Decoration," was published in 1807, and contained a large number of designs in a purely classical style. His first object in directing attention to this subject was to obtain furniture which should harmonise with the spirit of his collection of antiquities. The critics, notably Lord Jeffrey of the *Edinburgh Review*, laughed at the author, but in spite of opposition the book exerted a very wide influence. The introduction to Messrs. Light's book also contains some remarks upon the history of the several articles of furniture appropriate to the various rooms.

GENERAL NOTES.

Technological Museum at Sidney.—A Technological, Industrial, and Sanitary Museum for New South Wales is being formed at Sidney. This museum is intended to occupy a similar position and fulfil the same purpose in that colony as the South Kensington Museum, the Bethnal-green Museum, the Museum of Practical Geology, the Patent-office Museum, and the Parkes Museum of Hygiene do in London. To this end, it is intended to collect together typical collections of all materials of economic value belonging to the animal, vegetable, and mineral kingdoms, from the raw material through the various stages of manufacture, to the final product or finished article ready for use. The following are the chief subjects which will be represented:—1. Animal products. 2. Vegetable products. 3. Waste products. 4. Foods, animal and vegetable. 5. Economic entomology. 6. Economic geological specimens, showing the ores of the metals, their manufacture and uses; building and ornamental stones, clays, cements, glass, pottery, porcelain, pigments, &c. 7. Educational apparatus and appliances, school fittings, books, maps, diagrams, &c. 8. Sanitary and hygienic appliances and systems. 9. Mining, engineering, and machinery. 10. Agricultural tools, appliances, and machinery; also soils, manures, &c. 11. Models, drawings, and descriptions of patents. 12. Ethnological specimens. 13. Examples of historical furniture and of artistic workmanship in iron and other metals. 14. Photographs, electrotype, plaster, and other reproductions of examples of art workmanship where originals are not to be obtained. 15. Exhibition catalogues, trade journals, price lists, and descriptions of new processes or industries. The acting-secretary, Mr. Charles R. Buckland, asks for contributions to the museum.

MEETINGS OF THE SOCIETY.

ADJOURNED MEETING.

Monday evening, at eight o'clock:—

JANUARY 24.—Discussion on Mr. A. G. Lock's paper, "Causes of Success and Failure in Modern Gold Mining." HYDE CLARKE, Esq., will preside.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

JANUARY 26.—"Suggestions for Preventing London Smoke." By W. D. SCOTT-MONCRIEFF.

FEBRUARY 2.—"Trade Prospects." By STEPHEN BOURNE.

FEBRUARY 9.—"The Present Condition of the Art of Wood-carving in England." By J. HUNGERFORD POLLEN. Sir PHILIP CUNLIFFE OWEN, C.B., K.C.S.I., will preside.

FEBRUARY 16.—"The Participation of Labour in the Profits of Enterprise." By SEDLEY TAYLOR, M.A., late Fellow of Trinity College, Cambridge.

FEBRUARY 23.—

MARCH 2.—"Flashing Signals for Lighthouses." By Sir WILLIAM THOMSON, LL.D., F.R.S.

MARCH 9.—"Improvements in the Treatment of Esparto for the Manufacture of Paper." By WILLIAM ARNOT, F.C.S.

MARCH 16.—"The Manufacture of Aërated Waters." By T. P. BRUCE WARREN.

MARCH 23.—"The Increasing Number of Deaths from Explosions, with an Examination of the Causes" By CORNELIUS WALFORD.

MARCH 30.—"Recent Advances in Electric Lighting." By W. H. PREECE, Pres. Soc. Tel. Eng.

Dates not yet fixed:—

"Buying and Selling; its Nature and its Tools." By Prof. BONAMY PRICE. On this evening Lord ALFRED S. CHURCHILL will preside.

"The Discrimination and Artistic Use of Precious Stones." By Prof. A. H. CHURCH, F.C.S.

"The Compound Air Engine." By Col. F. BEAUMONT, R.E.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at eight o'clock:—

FEBRUARY 1.—"The Industrial Products of South Africa." By the Right Honourable Sir HENRY BARTLE

Frere, Bart., G.C.B., G.C.S.I., D.C.L., LL.D. Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L., will preside.

February 22.—"The Languages of South Africa." By Robert N. Cust.

March 15.—"The Loo Choo Islands." By Consul John A. Gubbins.

April 5.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

January 27.—"A New Mechanical Furnace, and a Continuous System of Manufacturing Sulphate of Soda." By James Mactear, F.C.S. J. C. Stevenson, M.P., will preside.

February 24.—"Deep Sea Investigation, and the Apparatus used in it." By J. G. Buchanan, F.R.S.E., F.C.S.

March 24.—"The Future Development of Electrical Appliances." By Prof. John Perry.

Indian Section.

Friday evenings, at eight o'clock:—

January 21.—"Forest Conservancy in India." By Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L. Andrew Cassels, Member of Council, will preside.

February 11.—"The Gold Fields of India." By Hyde Clarke.

March 4.—"The Results of British Rule in India." By J. M. Maclean.

March 25.—"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Second Course will be on "Watchmaking," by Edward Rigg, M.A. Three Lectures.

Syllabus of the Course.

Lecture I.—February 7.

Introduction—Units of Time—Historical Sketch—Description of usual forms of watch—Escapements—Conditions of accurate timekeeping, and arrangements necessary for their maintenance in the higher class of watch.

Lecture II.—February 14.

The ordinary watch—Degree of accuracy required in it—Systems of manufacture in this country and abroad—Description of specimens illustrative of the various stages of construction—Comparison of the several systems.

Lecture III.—February 21.

Necessity of efforts to promote the art in this country—Need of education, theoretical and practical, in horology—Literature—Great want of uniformity in gauges, screws, &c.—Exhibition of ordinary and complicated watches, and of watchmakers' tools—Conclusion.

The Lectures will be illustrated by Specimens, Models, and Diagrams. The different movements, &c., will be shown enlarged on the screen by means of the Aphengescope and the Electric Light.

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

March 7, 14, 21, 28.

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Three Lectures.

April 25; May 2, 9.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

May 16, 23, 30.

Admission to Meetings.

Members have the right of attending all the Society's meetings and lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 24th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Adjourned discussion on Mr A. G. Lock's paper, "Causes of Success and Failure in Modern Gold Mining."
Royal United Service Institute, Whitehall-yard, 8.30 p.m. Capt. L. K. Scott, "Suggestions for Improving Musketry and Artillery Fire, combined with an Explanation of Capt. Scott's system of Sighting Guns, practically illustrated by models."
Medical, 11, Chandos-street, W., 8½ p.m.
Royal Asiatic, 22, Albemarle-street, W., 3 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Dr. E. B. Tylor, "Problems in the History of Civilization."

Tuesday, Jan. 25th...Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. A. Schäfer, "The Blood." (Lecture II.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on "Deep Winning of Coal in South Wales."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. Annual Meeting.
Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Sir Alexander Galt, "The Future of Canada."

Wednesday, Jan. 26th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. W. D. Scott-Moncrieff, "Suggestions for Preventing London Smoke."
Telegraph Engineers and Electricians, 4, Broad Sanctuary, S.W. 1. Inaugural Address by the President, Prof. G. C. Foster. 2. "Mr. A. W. Heaviside, "Some Experiments on Induction with the Telephone."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. Robert N. Cust, "A Recent Tour in Spain, with Notices of the Al Hamra and of Spanish Customs."

Thursday, Jan. 27th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Chemical Section.) Mr. James Mactear, "A New Mechanical Furnace, and a Continuous System of Manufacturing Sulphate of Soda."
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. H. E. Armstrong, "The Manufacture of Indigo from Coal."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. Francis Hueffer, "The Troubadours." (Lecture II.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Friday, Jan. 28th...Royal United Service Institution, Whitehall-yard, 3 p.m. Colonel Thomas Innes, "The Training of Militia."
Royal Institution, Albemarle-street, W., 9 p.m. Dr. Arthur Schuster, "The Teachings of Modern Spectroscopy."
Quekett Microscopical Club, University College, W.C., 8 p.m. 1. Mr. B. W. Priest, "Sponges." 2. Dr. T. S. Cobbold, "*Filariæ*."
Clinical, 53, Berners-street, W., 8½ p.m. Annual Meeting.

Saturday, Jan. 29th...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sidney Colvin, "The Amazons." (Lecture II.)

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FRIDAY, JANUARY 28, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

HOUSE SANITATION.

The Council offer the following Medals for Plans showing the best Sanitary Arrangements in Houses built in the Metropolis, such plans to be exhibited in the Society's Rooms, Adelphi, in June, 1881, and to be sent in on or before 12th May, 1881:—

1. One Silver Medal for the best sanitary arrangements, carried out and in satisfactory working, in a house let out in tenements to artisans, for which a weekly rental is paid.

2. One Silver Medal for the best sanitary arrangements, in actual working, in a house of the yearly rental of £40, or less, to about £100 in value.

3. One Silver Medal for the best sanitary arrangements, in actual satisfactory working, in a house of the yearly rental value of £200 and upwards, to any amount.

4. The houses must be open to the inspection of the Judges, who, in considering their award, will be guided by the suggestions of plans for main sewerage, drainage, and water supply, made under the Public Health Act, 1875.* The houses must have been in actual occupation within the last three months, and a Certificate must be given by the occupiers, on a printed form, stating the satisfactory working of all the sanitary arrangements, such form to be obtained at the Society of Arts.

5. The houses may be old, fitted with modern sanitary arrangements, or may be new. They must be within the metropolitan area of the Board of Works.

6. The sanitary arrangements must include the conditions for good water supply, drainage, warming, and ventilation of the house, and precautions taken against frost.

7. The medals may be awarded to the occupiers of the houses, or the lessees, or the owners.

* The Public Health Act has been revised to 1878, and published by Her Majesty's Stationery Office. Price, with plans, three shillings.

8. The plans must consist of a ground plan and sections, to the scale of not less than one inch to five feet; details of not less than one inch to the foot. The plans may be accompanied by specifications.

9. The names of the architects, surveyors, or sanitary engineers who directed the sanitary arrangements should be given, and Certificates will be awarded to those whose plans obtain the Medals. (By Order)

H. TRUEMAN WOOD, Secretary.

DOMESTIC ECONOMY.

1. The Council will hold a Third Congress on Domestic Economy, at the Society's Rooms in the Adelphi, London, during the present year.

2. The Council offer Seven Bronze Medals, and Certificates of Merit for Papers (not exceeding 1,000 words), written by Teachers of Public Elementary Schools and Training Colleges, which shall give an account of the best method practised by the teacher, of the teacher's experience, and the result of the teaching, in any one or more of the seven classes of subjects named below.

3. The Education Department, in the Code of 1880 (p. 31), classes the following subjects under Domestic Economy for Girls:—

The First Branch includes—

(*a*) Clothing and Washing.
(*b*) The Dwelling—Warming, Cleaning, and Ventilation.
(*c*) Rules for Health—The Management of the Sick Room, Cottage Income, Expenditure, and Savings.

The Second Branch includes—

(*a*) Food—Its Composition and its Nutritive Value
(*b*) Food—Its Functions.
(*c*) Food—Its Preparation and Culinary Treatment (*i.e.*, Practical Cookery) (§ 24).

The Council have resolved to add the subject of Needlework, which will be exhibited and discussed in the Congress, although it is not classed in the Code as a branch of Domestic Economy.

4. Only one medal will be given to a teacher, but the subjects taught successfully will be inscribed on the one medal and a certificate given.

5. The papers must be sent to the Secretary of the Society of Arts by the 1st May next. Each paper must be enclosed in a sealed envelope, bearing a motto, and must be accompanied by an envelope bearing the same motto, and having within it the writer's name and address.

6. No medals or certificates will be awarded if the papers are not of sufficient merit to deserve them.

(By order)

H. TRUEMAN WOOD, Secretary.

EXAMINATIONS IN PRACTICAL MUSIC.

The following report on these examinations has been received from Dr. Hullah:—

The Society of Arts' Examinations in Musical Practice were held at the Society's House and (by the kind permission of Messrs. Chappell) at 50, New Bond-street, on the 10th and 11th inst. In the conduct of these, I was assisted by Mr. W. A. Barrett, Mus. Bac. Oxon., who had kindly taken the sole charge of them on the only occasions on which they had before been held, from both of which I had, unfortunately, been absent.

For these last examinations, 75 names had been entered, the owners of three of which did not present themselves. To the remaining 72, we had the pleasure of awarding 42 certificates of the first class, and 33 of the second. The maximum of marks assigned to the candidates is 100, of which 80 are needed for the attainment of a first-class certificate and 60 for a second. Of the former candidates, two attained the maximum number of marks, 100.

The majority of the candidates (63) were students of the pianoforte (59) or organ (4); (2) of the violin; and (23) vocalists. Of these 11 went in both as vocalists and pianists. Of four of these candidates, who also went in for "Honours," two attained first-class certificates, and one a second-class certificate.

Such a result as this demands a few words of comment, as well as of congratulation both to those who have instituted these and similar examinations as to those who have gone through them successfully. Though only in their second year, these practical examinations are an outcome of the examinations in the theory of music started by the Society of Arts in 1859; and, like those, are an evidence of the progress which musical science and skill have made in this country during the last twenty years. My own experience of them is of long date; and I have no hesitation in saying that they mark an amount of progress in execution, style, ear, reading, and general musical culture no parallel to which, in the same space of time, has been presented in any other age or country.

JOHN HULLAH.

London, Jan. [illegible], 1881.

INDIAN SECTION.

Friday, January 21st; ANDREW CASSELS, Member of Council, in the chair.

The Chairman, in introducing Sir Richard Temple, said he considered himself fortunate, on this opening night of the Indian Section, in being permitted to introduce so distinguished an Anglo-Indian as Sir Richard Temple. To those who were at all acquainted with India, his name must be as familiar as a household word. Few Englishmen, or natives either, had ever seen so much of India as he had, having traversed it in all directions. He had served the State in different capacities, with advantage to his Government and credit to himself. As he had the honour of being chairman of the Indian Section for the present year, it might not be improper for him to state, on this opening night, that one of the rules of the Society was, that all political topics should be avoided. He did not say this in reference to that evening's discussion particularly, but in reference to any papers which might come before the Society. If it were otherwise, as a member of the Council of India, he could scarcely hold the position he had the honour to occupy.

The address was on—

FOREST CONSERVANCY IN INDIA.

By Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L.

I am about to offer to you, not a lecture, but an oral address in a conversational style, if you will allow me. I must, in the first place, thank those who are present here for coming to this meeting on such a night, and in such inclement weather, but we shall have a larger audience of several thousand members of the Society outside, who will read the report of our proceedings in the *Journal* of the Society. I may say that I esteem it a great honour to be asked to deliver an address before the Society of Arts, remembering as I do, in common with all Englishmen, the great historical and distinguished part which the Society of Arts has played in the educational and industrial history of England during the 19th century. Not only has the Society done much for fine arts, of which we see traces in the room in which we are assembled, but more especially has it done great things in the application of science to all the varied industries of England. It has also done more, probably, than any other Corporation in England, for the advancement of technical education; and in the remarks I shall make to you regarding forests, you will find a signal proof of the mischief which has been wrought, mainly, from the want of technical and professional knowledge on the part of our own countrymen in India regarding forestry. I feel, however, much encouragement in addressing you this evening, when I look back on the names of the great men who have guided the deliberations of this Society, such men as the Duke of Norfolk in the last century, H.R.H. the Duke of Sussex, H.R.H Prince Albert, and now H.R.H. the Prince of Wales. We have also had and have now on the Council of the Society men whose names are really the property of the nation, such men as Wentworth Dilke, Lubbock, Leighton, and Galton. But more especially we have had on the Council many men who have contributed much to develop the industries of India in particular, such men as Cole, Sykes, Birdwood, Alcock, Siemens, Cunliffe-Owen, and Brassey. Well then, looking to these names of men, some departed, and others still present among us, we ought all of us, those who speak and those who listen, to feel the responsibility which attaches to all of us in assisting in the deliberations and proceedings of such a Society as the Society of Arts. Amongst its many educational and scientific operations, arboriculture was one of the earliest. As a remarkable instance, I may remind you that it is now nearly 130 years since this Society began to pay attention to forestry, an attention which, as you perceive, remains undiminished up to the present moment. It was soon after 1760, as you will perceive from the history of London, written by Charles Knight, and Davenport's history of our Society, that gold and silver medals, presented by this Society for planting firs and cedars, were won by such distinguished persons as the Dukes of Bedford and Beaufort,

Lord Paget, Earls Winterton, Ossory, Mansfield, and Wilton, the Bishop of Llandaff, and the Marquis of Tichfield. There were also men in those days whose names have been handed down in the history of British agriculture as well as arboriculture, namely, Curwen, of Windermere, Morse and John Hutton, of Yorkshire, and Bucknall. These men originally showed what could be done in the way of tree plantation in Great Britain, and it is to be hoped that they may prove to be the ancestors of a long line of Englishmen, who, from generation to generation, will distinguish themselves in arboriculture in all parts of the British Empire throughought the world.

From this brief preface, which I hope will not be uninteresting to members of the Society at the present time, I will pass straight to the subject of the evening, namely, "Forest Conservancy in British India." India, of course, is not the only country in which questions regarding forestry are becoming prominent. The mischief which has been wrought by the destruction of forests is patent on the face of Europe. The destructive floods which have occurred in many parts of France, are directly due to the denudation of the Swiss hills. Similar questions are being raised in South Africa, and we hear even of injury being feared in the United States of America. In India, the destruction has been vast. The traditions of the forests in India show how the land was once clothed with sylvan and other vegetation, but every time a city had to be built or a palace erected, or in modern times a railway to be constructed or barracks to be built, there has been a ruthless destruction of forests. Of course forests were made for the use of man, but they may be so cut as to leave something for reproduction. Instead of that "they have been swept away as clean as if they had been shaven by a razor"—I speak figuratively. Well, notwithstanding this destruction, still forests remain, though they can be hardly said to be more than the remnants of what once were the forests of India. You will say, perhaps, why did not the Government and its officers stop this devastation. They did not stop it, simply because they were none of them properly instructed in matters regarding forests. Such ignorance is not to be wondered at, considering the ignorance which has prevailed in Europe and in other parts of the world. I know that 20 or 30 years ago, when we were young men in India, we, none of us, heard of any principles regarding the forest conservancy. The consequence was that forests, being remote and difficult of access, not easy to visit or to understand, and we ourselves being ignorant of everything regarding forestry, we paid no attention whatever to the subject, and consequently, whenever wood was wanted, forests were cut down by persons who had nothing to do except to make as much as they could at the present moment, without regard to the future, and so forests have been destroyed in the most thoughtless and merciless manner. Still, there are great mountain ranges, for instance, the Western Ghauts, which form a mountainous wall on the western coast; the Eastern Ghauts, which form a similar range, although not so regular, on the eastern coast; two great ranges, the Sathpura and Vindhyas, which unite in the direction of Bengal, and form one broad mountainous region; there are the mountain ranges on the east of Bengal, separating Bengal from Burmah; and, lastly, there is the great Himalaya range itself. I do not now speak of the mountain range on the west of the Indus, because that was originally a region mainly destitute of vegetation, and whatever vegetation there was has long been swept away by the action of man; so that really the great range which separates India from Afghanistan counts for nothing, in the language of forestry. The ranges with which forestry in India has to do are the Western Ghauts, the Eastern Ghauts, the Sathpuras and Vindhyas, the Eastern Bengal ranges, and the mighty Himalayas.

In these mountain ranges, there are numerous kinds of trees, which constitute a forest flora in themselves. It is quite impossible for me, within the time at our disposal, to even enumerate, much less describe to you, the various kinds of trees which exist in the Indian forests; still I may mention, by way of recapitulation, some of the most striking and interesting trees which we have. The trees of India must be divided mainly into two main divisions, the Himalayan division, and the plain division, which latter comprises the whole of India proper.

Now, the Himalayan trees are allied mainly to the trees of Europe and other temperate regions. The *coniferæ*, including the great genera of firs, pines, and the like, are found all over the Himalayas. Amongst them the queen is the cedar. Nowhere in the world are such fine cedar forests to be seen as are in the Himalayas. You have some idea, in this country, from the lawns of our principal country seats, of what beautiful shape and colour the foliage of the cedar is; then imagine trees much grander, much finer in trunk, and branch, and foliage, with a background of everlasting snow; imagine them situated in the midst of rugged situations, and with the most glorious surroundings. And there is a further interest attaching to them, from the way in which they are felled, and the mode in which the logs, when felled, are transported to market. The value of a cedar forest depends on its situation. If the trees stand upon precipitous sites, overhanging rivers, they are felled to great advantage. The tree is felled, and the log is shot down the precipice into the roaring, cataract-like, torrent of the river. The river itself acts as a carrier, and whirls log after log down to the plains. And as the river, laden with all this freight of cedar logs, emerges from the Himalayas, skilful native swimmers are stationed on the bank, and dart forth and catch the logs as they descend the stream.

Similar remarks apply to the *Pinus longifolia*, which is, next after the cedar, the most valuable timber tree in the Himalayas. In fact, in Northern India, most of the great public buildings of the British Government, and most of the palaces of the native princes, are largely constructed with the timber of cedar and pine. As a matter of interest, I should not omit to mention the cypress. But the cypress of the Himalayas is not the funereal sort of tree which you read of, or see depicted, as constituting a great feature in the cemeteries and burial - grounds of the Levant or Constantinople, but is a truly magnificent tree, growing, too, in the very midst of the limestone formations. There appear to be certain chemical elements in the limestone which

favour the growth of the tree, and the consequence is, that the cypress may be seen fringing limestone precipices, where you would suppose that no vegetation could possibly grow—in places, indeed, where the only vegetation perceptible consists of these cypress trees, growing, as it were, out of the very crevices of the rocks. But, as regards funereal aspect, the most mournful looking tree in the Himalayas is the fir, which is named the *Abies Smithiana*. That, indeed, has long, pendant foliage, of a very weeping, mournful appearance, but still impressive and picturesque, especially when combined with other foliage, and more particularly, perhaps, when it is adorned by the beautiful golden red of the Virginia creeper. Imagine the bright scarlet leaves of the creeper winding about amongst the dark coloured, mournful-looking foliage of the fir, and you have a delightful picture.

Then another tree, most beautiful in the Himalayas, is the yew. It does not grow there singly, as it does in this country, but in a few spots among the Himalayas it grows in a dense forest, limited in size, but extremely thick; and nothing can equal, from an artistic point of view, the beautiful forms of these dependent branches and the foliage of these yews. The beautiful lines of Wordsworth are applicable to these yew forests—

> "Joined in one solemn and capacious grove
> Huge trunks, and each particular trunk a growth
> Of intertwisted fibres serpentine;
> Nor uninformed with phantasy, and looks
> That threaten the profane—a pillared shade.
> Upon whose grassless floor of red brown hue
> By sheddings from the pining umbrage tinged
> Perennially . . . . Ghostly shapes
> May meet at noon-tide."

Lastly, I should mention the juniper. This tree is extremely fine in the Himalayas; and when I mentioned to you just now that the trans-Indus range, near Afghanistan, was almost treeless, I ought to have made one exception in favour of the juniper. We hear now much of the Bolan Pass, and of Quettah, but the only valuable timber you have near Quettah consists of juniper forests, which grow near the summits of the limestone formations, 10,000 or 12,000 feet above the sea, which overlook those valleys, now so interesting to us from a political point of view.

Then, passing from this great natural order of *coniferæ*, we come to the other trees which are very familiar to us all in this country, the ilex, the oak, and the walnut, which are found in great abundance at Simla, where, as you know, is the residence of the Governor-General and his Council in the summer months. Near Simla, there grows the holly. In that locality it is not a shrub, as it is in this country, but a very fine tree of 50 to 60 feet high. I ought also to mention the plane tree. The plane tree is a great glory and ornament of the happy and world-wide celebrated valley of Cashmere. The scenes of the poem, Lalla Rookh, were laid in the midst of plane groves. Plane trees formed the ornament of the gardens of the great Mogul on the margin of the beautiful lake of Cashmere. The famous wooded island which stands in the midst of the lake is adorned with plane trees; in fact, in Cashmere, the plane is the crown and glory of the valley. In the eastern part of Himalayas, near Darjeeling, we have the maple; also the magnolia, which is brilliant with masses of white flower, so that it looks in the midst of summer as if it were sprinkled with fresh snow. The laurel grows there to a great height, not like the shrub as we see it here, but as a great tree 70 to 80 feet high. The tree fern is probably the most graceful member of the vegetable kingdom to be seen in the world—the tree fern of the eastern Himalayas. No word-painting of mine can give you any idea of the minutely graceful character of the foliage of the tree, especially, too, as it is generally seen with the distant background of the highest snow mountains in the world.

Before we leave the Himalayas, I must say one word about the rhododendrons. The discovery of the Himalayan rhododendrons is mainly due to Sir Joseph Hooker, the distinguished director of the establishment at Kew. With great toil and hardship, and with much exertion, he discovered and brought to England specimens of most of the finest species of rhododendrons. The tree does not grow there in shrubs as you see in this country, but attains a height of 20 to 30 feet. Its flowers, seen in its native habitat, are almost as large as a man's head. The leaves found on the trees there are 12 to 13 inches long. The branches and the trunk are permeated with a sort of red colouring matter, so that the whole of the tree seems ready to burst out with red; anything more magnificent than the appearance of this tree cannot be imagined. It is generally found in the midst of very rocky scenery; it flowers with great abundance, at altitudes of 12,000 to 13,000 feet, and that generally at a season in May and June, when the long winter of that region has hardly passed away, so that the rich flowers are faded and bleached in a day or two after blooming by the masses of fog and driving rain, and sometimes even of sleet, to which they are exposed.

So much, then, for the trees of the Himalayas. I regret that time does not admit of my dilating more fully upon them.

I must pass rapidly on to the trees of the plains. The first I shall mention of course is the teak, or *Tectona grandis*, which is the queen of trees in the plains, just as the cedar is the queen of trees in the mountains. It is said by enthusiastic foresters to possess every virtue of which wood is capable. It is good underground, it is good on the water, it is good in the burning sun, it is good everywhere, and under all circumstances. It carves well; it is light, it is durable; it will stand wet, and is seldom affected even by insects. It is used, as you know, largely by the British Admiralty. Its appearance always attracts the eye of the observer, on account of the arrowy manner in which it shoots up. Even the young tree, which is hardly a foot or two above the ground, always looks like an infant giant, or a young Hercules, amongst trees, by the striking manner in which it rises from the ground and seems to aspire upwards.

Then there is sāl, or *Shorea robusta*, which is commonly called the iron-hearted Sāl, on account of the great strength and durability of the wood; but it has not nearly so many virtues as the teak, especially in that it is so very heavy. But its appearance is very fine, with a tall, straight trunk, and branching head. It is to be found in the greatest perfection near the source of the Nerbudda, near the point where the two ranges of the Sathpuras and Vindhyas unite. Next I should

mention the two finest kinds of the natural order of the *Terminalia*; the *arjuna*, or anjun, is remarkable for the beauty of its trunk, which can only be likened to a great marble pillar. The trunk is absolutely white, bright, and smooth, generally growing amidst rocks, on the margin of streams, and in a very hot climate. The trees I have hitherto been describing grow in the cool, but this tree grows in the midst of the greatest heat. The other kind of terminalia is the *Pentaptera tomentosa*, or sāj. That is the very opposite in appearance. Instead of having a white and smooth trunk, it has a black and rough trunk, and, as the two trees often grow in juxtaposition, the effect is as though you saw a pillar of smooth white marble and a pillar of black rough stone placed close together. Then there is the *Pterocarpus marsupium*, or bije sāl, also a tree with a black-looking bark. In contradistinction to them, I may mention the salai, or *Boswellia thurifera*, commonly called the frankincense-tree. I have just mentioned the bije sāl, which has a rough, black bark, and, in contrast to that, I mention the salai. Instead of black bark, it has white bark; instead of a straight trunk, it has a winding, bending, straggling trunk, with branches thrown out in a kind of weird, wayward manner. The salai, in summer-time, may be called the ghost which haunts the forests of India.

The trees which I have just mentioned grow always on the mountain ranges of British India, as contradistinguished from the Himalayas; but I must now mention some of those which grow in the plains.

First of all there is the babul, or *Acacia arabica*. That is the one tree which is universal in India, and is used almost for every purpose which is useful in the daily lives of the natives. Then there is the mango-tree, which is known, of course, in this country on account of its fruit, and which furnishes a staple article of food to the mass of the people. But it is also valuable for timber. It is found in fine avenues on the sides of roads, and in sacred groves near to the Hindoo temples. Then we have the sundar tree. You have often heard of the Sunderbunds, that great, semi-marine forest which grows on the low, sandy region near the mouth of the Ganges. They are called the Sunderbunds, but that name is really derived from the sundar, which is the principal tree in that part of the forest, extending for thousands of square miles. In that forest, the most remarkable tree is the sundar, from which all the country boats of Bengal are made. As you may have heard, the river traffic in Eastern Bengal is, perhaps, the most extensive thing of the kind in the world. The network of rivers are navigated by hundreds of thousands of boats. The boats there are to the inhabitants what carts and wagons are to the inhabitants of other countries; and all these countless boats are made from the sundar tree, which grows in the forest I have described, near the mouth of the Ganges.

Then we have the different kinds of fig tree, or *Ficus*. There is, first of all, the ordinary *Ficus*, which is known popularly throughout the world as the banyan tree. That is the tree under the shades of which whole regiments are occasionally encamped. It is the tree which you have read of in Milton, and in the works of many modern poets. The beauty of the tree consists in the manner in which it throws down tendrils from its branches, which take root in the earth and form fresh trunks; so that a finely-developed banyan tree looks like the interior of a great Gothic structure. The tree has its colonnade, its arches, its aisles, its naves, and its transepts, and its roof consists of the densest foliage, so that the perspective view, taken in the interior of one of these great banyan trees, is, perhaps, the finest sylvan subject which the artist can possibly have for his brush or his pencil. Then there is the pipal, which is called *Ficus religiosa*, which is to be found near every Hindoo temple. It is remarkable for the manner in which its branches entwine themselves amidst the masonry. You know the old song—

> "Creeping where no life is seen,
> A rare old plant is the ivy green."

Similar to this is the *Ficus religiosa*. It is always to be found in the midst of ruins; in fact, it is one of the causes of old buildings becoming ruins, for once it insinuates itself into the building, it gradually works its branches and its tendrils through all the interstices of the masonry, until possibly the whole structure is embraced in its fatal grasp. The building then becomes like a human being seized by a boa constrictor, or like the Laocoon encircled in the folds of the Python. Lastly, there is the *Ficus elastica*, or india-rubber tree, which many ardent foresters believe will, ere long, more than rival the india-rubber trees of South America.

Then there is the bamboo, the beautiful feathery bamboo, which affords the means of constructing almost all the huts, cottages, and villages of the inhabitants of Bengal. But, besides what may be called the domesticated bamboo, there is the wild bamboo of the forests of Central India, which is truely a lovely tree. A single shoot of the bamboo has been shown at an exhibition, to the height of 80 or 90 feet, with a little flag at the top. These bamboos, too, generally overhang the pools of rivers, so that taking these great, beautiful, graceful bamboos, bending over the stream, and the reflection in the stream—together forming almost an arch in appearance—a more picturesque object cannot possibly be imagined.

Lastly (I hope I have not wearied you by describing these various trees) we come to the palm. Now, the first of the palms to be mentioned is the date-palm, that is the kind which is known to poetry as the feathery palm. Our Indian date-palms are, no doubt, not so fine as those of the valley of the Nile, and on the banks of the Tigris and Euphrates, which run into the Persian Gulf. Still, next after these, our Indian palms are the finest in the world. Sometimes they grow singly, but often they are to be found in great clusters, and often in long, straight avenues. Then we have the Palmyra palm, with great fan-like leaves, just like a human hand stretched out. It is, perhaps, more noxious than beneficial, for from it some of the strongest spirits in India are distilled. Then, lastly, I shall finish my mention of trees by describing the cocoa-nut. Now, the cocoa-nut, probably, taking it all in all, is the most useful tree of all the trees in India, for it is commonly said—and truly said—that the cocoa-nut will provide everything which a human being can require. It will give him the most nutritious food, slightly oleaginous, perhaps, but

still very strengthening; it will also give him the sweetest and most delicious drink; it will afford him everything that he can require for clothing; it will furnish him with roofing for his house; and it will give him not only the roofing, but the rafters. It will supply timber for the pillars upon which the edifice rests, and it will also give him the best material for rope; so that there is not a single use which man can require in the vegetable world which is not supplied by the cocoa-nut, and the cocoa-nut of India is second only to that of Ceylon, if, indeed, it is second. It grows in the greatest abundance all along the Malabar coast. There the cocoa-nut tree constitutes a little freehold—a little property—for actually the land revenue in some districts is based upon the cocoa-nut trees. That is to say, a man and his family get their living and pay their revenue out of a few cocoa-nut trees, so valuable is the tree.

Now, I wish I could dwell much longer on all these beautiful, interesting, and useful kinds of trees in India. I have hoped to induce you to feel an affectionate interest in them, to love the forests, so that they may live in your imaginations as they live in mine. But, from this brief summary of the subject, I must pass on to the question of how all this vast national wealth should be preserved.

Before doing so, I must first say something as to the reasons why the trees are valuable. They are valuable you will find, I think, for two main purposes, one economic, and the other climatic, and I will touch upon each of these subjects separately.

First I will allude to the economic purposes. Now, the preservation of forests is desirable for the purpose of conserving the great wealth with which nature has endowed India for the use of man. There are no less than 37,000,000 of inhabited houses in British India, and I need not say that for every one of those houses wood is required. The majority of these 37,000,000 houses are constructed mainly of wood, so you can imagine from that what an enormous demand there must be in the vast British Indian population of 200,000,000 persons for timber for house building alone; besides, there are 40,000,000 of inhabitants of native States. Again, most of the domestic implements of the people are made of wood. No doubt, implements of various metals are being substituted for implements of wood, but, still, wood enters more largely into the consumption of the Indian population than that of most populations in the world for domestic implements. Among agricultural implements, take ploughs for instance, there is no accurate return of the number of ploughs in British India, but the best returns show at least 8,000,000 of ploughs. That, probably, is much below the mark. If you consider that there are not less than half a million villages, if there are 10 ploughs to a village, that would give 5,000,000; if there are 20 ploughs to a village, that would give 10,000,000; and if, which is much more likely, there are 30 ploughs to a village, that would give, perhaps, 15,000,000. From these facts you can judge what an enormous demand there is for wood, even for implements of agriculture. Then there are the carts. It is almost impossible to give any idea of the number of carts. There is no proper return of them, I am sorry to say, but they must be counted also by many millions; and as for the boats, in some parts of the empire they are also to be numbered by hundreds of thousands. Then, also, there is the consumption of fuel. Now, to meet the demand for all the purposes I have been hitherto mentioning, wood is somehow found from the forests; but, for fuel, there is, in most parts of India, an absolute want of wood, and the consequence is that the people use for fuel the cow-dung which ought to be used for manure. You hear very much in India of the gradual exhaustion of the soil. I hope (and that is all we can say) that the exhaustion is very gradual. It certainly does appear, from many proofs, to be very slow. But, at all events, the gradual exhaustion of soil is to be feared, unless the people can have some better means than they have at present for obtaining manure. At present, much of the natural manure of the country is being used for burning, and you can imagine from that what a grave disadvantage is inflicted upon a country from the want of the conservancy of the forests. In fact, the agriculture of the country is suffering greatly from this cause. So much for economic purposes.

You will readily perceive how numerous and extensive the markets must be for timber and fuel, how difficult it is to keep them adequately supplied, and yet how fatal to the country it would be if they were to become depleted. Without a system of State conservancy, the forests would shrink and shrink, while the population increases; materials in wood and timber would become scarcer and scarcer; the price of fuel would rise, so as to press heavily upon the poorer classes.

But there are other purposes, namely, the climatic. There are many people who think the droughts with which India is periodically visited arise from the destruction of forests. Too much, perhaps, must not be made of that cause. There is a certain amount of evaporation from the Indian Ocean, there are certain masses of clouds, and they must condense somewhere, so I do not suppose the total rainfall of the continent of India can possibly be effected by forests; but the distribution of the rainfall is probably very much affected. The clouds pass over the dry plains, and go straight on to the mountains. They arise in the Indian Ocean; the first obstruction they meet with is from the wall of hills which I have described to you along the western coast, but, passing over this wall of hills, they sweep over the dry plains of India, and then they meet with the Sathpura and Vindhyas ranges which I have described. They are stopped there; they condense on these ranges, and then cause torrents of rushing streams to arise and swell the rivers. Thus the clouds return back to the plains in the shape of floods, and sweep away the railway viaducts, and carry roadways to destruction, and so effect numerous damages. Now, a great deal of these floods might have been avoided, had the clouds been arrested in their course over the plains, and this arresting can only be brought about, in the opinion of the best judges, by the preservation of the forests. If the forests exist, a cool surface is presented to the clouds, which causes them to stop and condense into rain, and drop fatness on the earth. If there are no forests, the clouds pass

on in the upper stratum of the air, until they are stopped by the hills.

The same description applies to Bengal; the vapours arise from the Bay of Bengal, and are swept over the plains of Bengal, and are stopped by the great mountain ranges which divide Bengal from Burmah; or, again, they sweep over the upper valley of the Ganges and Jumna, until they are checked by the Himalaya. Time does not admit of my properly entering into this meteorological subject, but you will see, from these main facts, how very probable it is that the existence or non-existence of forests may greatly affect the distribution of the rainfall. If there are no forests, the probability is that at one time there will be droughts, and at another time immoderate rains, for a period of floods almost always follows, according to past experience, a period of drought. Thus it is to the forests we must partly look for being blessed with the early and the latter rains in due season.

I pass then to another point with regard to climatic influences, viz., the retention of moisture. There is no doubt that forests produce this result very considerably. If the vegetation is destroyed, the streams run dry unseasonably, and the wells have but a scanty supply of water. If the vegetation is preserved, the excessive moisture of the rainy season is stored by a natural process, for the use of man during the dry season. More especially is this important in those parts of India where canals have been constructed. Some of the canals of India are drawn from rivers which have their source in the Himalayas, in the perpetual snow, and for them forests are not of great importance. But many of the canals of India are drawn from rivers which rise in the mountain ranges of India itself, and if these mountain ranges are denuded of vegetation, those streams which feed these precious canals will all run dry in seasons of drought, so that, if we are to maintain our great canal system in full efficiency, we must preserve the forests near the sources of those rivers.

One more point with reference to climatic considerations, and that is the preservation of pasturage. The cattle in India have too much food at some seasons, and too little food at other seasons, and the consequence is that the animals, which have been suffering from depletion or inanition during the dry months, are apt to surfeit themselves as soon as the vegetation bursts forth into life upon the commencement of the annual rains. Now, the great object is, by preserving forests, to preserve the grass during the dry seasons. If there is a certain amount of vegetation, the grass is sheltered from the burning sun, and will thrive and afford fodder for cattle, whereas, if all the vegetation is swept away, grass will not thrive. For that reason, many experienced men think more ought to be done in the plains of India for the establishment of what are called communal forests, and that every village, or cluster, or circle of villages, should be induced or compelled to combine for the establishment of communal forests, which shall afford a certain amount of timber and fuel, and shall also preserve the grass for the cattle.

These are the main reasons, in brief, why the preservation of forests is a matter of such vital importance and national concern in India.

I then come to the measures to be taken for preserving these forests. I have sorrowfully admitted to you the neglect on this subject, which has prevailed in former years. Nobody is more zealous than I am in vindicating the character and conduct of our Government and officers in India, but I must admit that in respect of the preservation of forests, we have not, until within the last 20 years, done as much as it behoved us to do. I attribute that not to any wilful neglect, but simply to the fact which I stated at the outset of my address, namely, a want of knowledge. It is the deficiency of technical education on this subject which has caused the partial destruction of these great sources of national wealth—a wealth too, which, as you see, is essential to the well-being of the country. But, of late, we have been mending our ways in that respect, and we have established a very highly organised department of forestry. We now have a large staff of trained forest officers—I wish I could add that they had been trained in this country. You may have seen lately that there is a project for establishing a forest school in England, in connection with the forest of Epping; hitherto, however, our English forest officers have been trained, not in their native country, but in France and Germany; and we must acknowledge the great debt we owe to our gallant neighbours, the French, for the excellent forest school of Nancy, which has given us many English officers for the benefit of the Indian forests. Still, I do not see why forestry should not be taught in England as well as anywhere else. You do not require a very large or extensive wild forest, in order to learn the principles of forestry. Any of the numerous woods and covers which adorn the undulating valleys of England would do perfectly well for instructing Englishmen in the art of forestry, to say nothing of the woods which may be found in Scotland or Wales. But, at all events, it matters not so much where the men are instructed, as that they should be well instructed somewhere; and I am happy to state that we have now a Forest Department of India which, in respect of scientific, technical, and practical knowledge, is second to no similar department in the world.

Now, you will ask, what exactly does this great department do? In the first place, the remaining forests—I must call them remaining forests, because you see how the ancient forests of the country have been destroyed—are divided into two great categories. They are divided by law (for the matter has received careful attention from the Legislature) into two classes; firstly, reserves, or the forests which are absolutely guarded; and, secondly, the protected forests, which are imperfectly guarded and preserved. To give you any idea of the extent of these forests, I must mention to you the area in square miles, and you will find that at first sight the area does present a respectable aggregate or total. In the Punjab there are now 4,000 square miles; in the North-West Provinces, 3,000; in Bengal, 9,000; in Assam, 7,000; in the Central Provinces, comprising the Sathpura and Vindhya ranges, which I have mentioned several times, 20,000; in Berar, 5,000; in several miscellaneous districts, 1,000; in British Burmah, 2,000; which are, probably, the best forests in the empire. All these make up, for the Bengal Presidency, a total of 51,000 square miles. To this you must

add 13,000 square miles for Bombay, and 5,000 for Madras, which make up a grand total of 69,000 square miles, or, say in round numbers, 70,000. This sum total will, ere long, be augmented, because there are many thousand square miles yet to be marked off in British Burmah, and, I believe, there are some thousands of square miles also to be marked off in Southern India, within the limits of the Madras Presidency, so that, I dare say, within a few years, we shall have not less than 100,000 square miles of forest in India, which, I hope, is a figure worthy of being mentioned before a distinguished Society like this. But it were vain, if I were to lead you to believe that the whole of this area, of 70,000 sqaare miles, is properly protected; I am afraid that the greater portion of it is imperfectly protected; but, still, I think that nearly half is really well preserved; and I see that the Famine Commission, in the very careful report they have recently made on the resources of India, say that 25,000 square miles are thoroughly guarded and preserved; but at all events, the whole of this great area is, more or less, under some protection and supervision.

The Forest Department, as above described, manages directly all the forests technically described by law as "reserved," and supervises the management by the ordinary civil officers of the forests technically described as "protected." From these forests, the markets for timber and fuel are largely supplied. The proceeds for all British India amount to about three-quarters of a million sterling annually, and the expenses to half a million. Thus, the department defrays all the charges for the conservancy, and yields a small revenue to the State. Many articles of wild forest produce, such as gall-nut and sandal-wood, are sent to the great marts for exportation abroad.

Besides the area of forests, as above set forth, there are extensive areas of jungle of equal, probably more than equal extent, left in the hands of the people, under the terms of the Land Revenue Settlement. From these jungles most of the local wants of the country, as above mentioned, are supplied.

The first-class timber markets are, however, supplied from the "reserved" forests, and the second-class timber markets from the "protected." From both kinds of forests excellent fuel is obtained.

The railways were at first worked with wood fuel; but coal is largely used, now that the mines are being opened. With a good conservancy system, however, there ought not to be any apprehension on account of wood being consumed by the railways. For forests could, in many places, be formed all along the lines of railway, and would supply fuel, while improving the country.

Then the question arises as to what does this preservation and guarding consist of, and to what intents and purposes are the forests protected? Well, now, they are first protected as to the matter of wood-cutting. The forests are not treated by the Government as if it were the dog in the manger. Timber is intended for the use of man, and the object is not to preserve the trees for ornament, but for use. As soon as a tree has attained its utmost development, and grown to its full height, it is fit to be cut, and ought to be cut; and in many cases trees grow so thickly together that thinning of them is a positive benefit to the vegetation of the forest. So, then, the restrictions upon wood-cutting are not made absolute, but are instituted in order to insure that a certain number of trees shall always be left for reproduction.

The next point is to regulate the practice of what is called "rab." Now, rab means this—that the new shoots and sprigs of the trees are burnt, and their ashes are used for manure. You will readily understand that such ashes contain many of those chemical constituents which are needed for manure, especially where much of the natural manure of the country, viz., the cow-dung, has been used for fuel. Now, this practice of cutting the sprigs of trees, and burning them for ashes for manure, is a practice which, if not regulated, will cause great damage to the forests; but, nevertheless, to a certain extent it is necessary.

Then another matter is the prevention of the jungle fires. These jungle fires are partly accidental and partly intentional. When they are accidental they present some of the most magnificent spectacles you can possibly imagine. I, myself, and many other people in India, have been sometimes out at night in the midst of these fires, and you then see some of the grandest, if not, perhaps, the most alarming sights you ever witnessed. The way in which the devouring element rushes over the country, travelling sometimes at the rate of several miles an hour—the wild animals fleeing before it in terror, the native inhabitants of the forests sometimes even being caught in the flames and being burned to death, poor men, and occasionally even mounted Europeans having to gallop away to escape from the vast rushing conflagration—all these things constitute a wonderful sight. Then, the manner in which the trunks of the trees form as it were pillars of fire, or the clumps of bamboos rattling and crackling just like the roll of musketry, and sometimes the sound of the falling forest, and the roar of the flames is not unlike the resonances of artillery or the thunder of Heaven. Again, the manner in which some of the trees smoulder is quite wonderful. Stories are told of trees sometimes burning for many months together, and one I heard of, or rather read of, as having burned for three years consecutively. First, the trunk smouldered, then the fire got to the roots, and gradually burned through the radicles for months and months together.

Now, you will readily imagine what mischief is caused by such conflagrations as these spreading over many square miles. Yet the cause of the accident is often trifling, a wayfarer lighting his pipe, a labourer cooking his dinner (after the Oriental fashion) in the open air. With a system of conservancy, these accidents are minimised, or almost prevented altogether. Without such a system, they become terribly frequent.

But the fires are also intentional, and are lighted up every year to insure the plentiful growth of fresh green grass for the grazing of the cattle. Of course, to some extent, that is permissable, and the hills at the back of Bombay, in the months of April and May, are lighted up at night with a magnificent illumination. In fact, so popular is the practice, that, whenever there is any political disturbance anticipated, the natives say "the fire will be out on the hills," and

from that we understand there is going to be a disturbance.

There is another way in which the burning of the fires are intentional, viz., this, there are many wild hill tribes who carry on their agriculture, not by means of ploughing, but by means of burning fires, and letting the ashes lie on the ground until the rains come. Then the rains descend on the virgin soil, which, fertilised by the ashes of the burnt forest, produces abundant crops without any further labour whatever. This, of course, is an utterly barbarous practice, and it arises only from the ignorance of the people. No doubt the localities are often very steep, and it is not so easy to plough as it would be in the plains, with these very sharp gradients. Nevertheless, the practice arises from ignorance on the part of the people and from their want of agricultural capital. The object of the British Government is to wean these poor people from the barbarous practice, to reclaim them from habits of agricultural savagery, and to make small advances of money to them for purchasing ploughs and plough cattle, and so teach them to depend on settled agriculture rather than on these wasteful destructive fires.

Then, another purpose to which the forest conservancy is directed is the preservation of the grazing. If the cattle are allowed to wander unchecked in the jungle, they will eat a little and destroy very much; that is to say, they will tread down and trample and destroy uselessly ten times as much as they consume for food. The object, therefore, is to restrict the grazing by means of a sort of block system, that is to say, to allow the cattle to graze in certain blocks or areas of forest range, and to prevent them grazing in others. The block or area is protected from grazing, and as soon as its vegetation has grown up, then the cattle may be admitted to graze safely. Of course cattle must have pasturage, and the object should be to provide pasturage ground sufficient for their real consumption, but to prevent them from needlessly destroying the vegetation.

It is this useless destruction of the pasturage, from want of conservancy, that renders the country so destitute of fodder whenever drought occurs. It is essential to husband the spontaneous fodder of the country, as a resource to be available in time of need.

In all these matters you may readily perceive that the question arises of the restriction of the rights of the people, and there is, to some extent, a slight contest always going on between the forest officers and the ordinary civil officers of the Government. The forest officers, of course, are zealous for preserving the forests, and the civil officers naturally protect the rights of the people. The object is to maintain a judicious compromise. The people who sparsely inhabit the forests have been accustomed to cut, burn, and destroy somewhat recklessly, and they cannot speedily be reclaimed from these evil habits. This can only be done by degrees. But while, on the one hand, their reasonable rights are protected, on the other hand, they must not be allowed to destroy forests altogether, otherwise there will be no *corpus*, as the lawyers say, on which any rights are to be founded; the whole property of the country will be destroyed, the natural wealth will vanish, and there will be nothing for anybody to have rights in at all. So that, in a judicious gradual and conciliatory manner, forests must be preserved, while a fair and equitable consideration is given to the well-established customs of the country, notwithstanding that these customs are, to some extent, objectionable.

The "reserved" and "protected" forests, technically described above, have been adjudicated, after inquiry, to be the property of the Government. Full provision is made by law for determining disputes between the people and the Government authorities regarding the ownership of the forests, and the boundaries are defined of the jungles which belong to the State and to the natives respectively. An ample quantity of jungle has everywhere been marked off as belonging to the people, and within that area no restrictions are placed upon the natives. The restrictions exist only in those forests which from time immemorial have belonged to Government under native dynasties as well as under British rule. Within some of the Government forests, especially in the technically "protected" forests, subordinate rights are found to pertain to the natives, under the Government, as lord of the manor. These rights are also investigated under the law, and defined.

Thus no just cause of complaint whatever is allowed to exist on the part of the people against the forest system, though there is no disguising the fact that many would desire to cut down the State forests at their will for immediate gain, without any care for the future.

There are certain things which in all countries are recognised as pertaining to the business of the State, or rather public authority, such as the coinage, the post-office, the electric telegraph, besides the important departments of sanitation, education, and the like. In some great branches, the State, if it does not directly undertake the management, does yet interfere considerably, notably in the case of railways. Now, in India at least, forest conservancy is to be classed in this category. There are many things in which private enterprise is better than State action, but forest conservancy is not one of these. The saddest experience has shown that if forests are left to private action unrestricted, they will be destroyed. Hundreds of tracts are to be seen in India, now bare and barren, where forests and vegetation once abounded, and might again abound under a proper system of conservancy. Hundreds more of tracts exist where the denudation has occurred within the present generation. Sadder still, in many places the mischief is irreparable, because the soil has been, after the loss of its vegetation, washed away by the action of rain. If left to themselves, the people would work out the forests to destruction, just as a spendthrift lives on his capital—in homely phrase, they would kill the goose which lays the precious eggs. The true object of conservancy is to preserve the forests as an inestimably valuable capital with which nature has endowed us, and to draw from these, for the use of the people, interest, in the shape of timber fuel and other produce judiciously cut or felled, and grass or fodder grazed according to a scientific system. It is this which is now being done effectually, though but too tardily, in India. If forests are worked without any State supervision, they are exhausted, and

nothing is left for reproduction. If they are worked by the State, then some trees are always left to keep up the vegetation.

I have now touched briefly, and I am afraid imperfectly, according to the short time at our disposal, on the nature of the forests, on their value, climatic and economic, upon the means which should be provided by the Legislature and the executive for preserving them, and the objects to which that preservation is directed. Before I resume my seat, and invite discussion on these very interesting and important topics, I would desire to re-call to the grateful recollection of patriotic Englishmen, the names of some of our countrymen who have most distinguished themselves in respect of forest conservancy in India, but I must first mention two distinguished Germans. It has always been the pride of the Indian Government to attract to its service eminent men of other nations, and amongst its best servants is Dr. Dietrich Brandis, who has done more for forest conservancy than any other person who could be named, for not only has he organised a system which is scientific and practical, but he has also contributed much to botanical science in India, and is the author of an excellent work, entitled "The Forest Flora." Next after him I would mention his distinguished countryman, Dr. Schlich, who, for a long time, was Conservator of the forests of Bengal and Assam. After them I would mention Dr. Cleghorn, of Madras, who I am happy to see present amongst us this evening. Then there is Dr. Stewart, the late Dr. Dalzell, of Bombay, Mr. Beddome, and Maj. Campbell Walker, in Madras; Col. Pearson and Capt. Forsyth, of the Central Provinces. Capt. Forsyth was one of the men who worked so hard in the forests, that I may say he almost laid down his life for their sake, and has left, as the memorial of his labours, one of the most charming books on forestry that has ever been written. In Burmah, the forest department has been well represented by Messrs. Seaton and Ribbentrop. Then I may mention the two other zealous officers who are now carrying on forest conservancy under great difficulty in the Bombay Presidency. These are Mr. Shuttleworth and Col. Peyton, and lastly I would particularly mention a member of the Covenanted Civil Service, Mr. Baden Powell, in the Punjaub. These are the men who have struggled to preserve our forests through evil report and good report, with a considerable measure of success, and who have, from their sense of public duty, from their regard to the welfare of India, and from their love of the forests, borne much hardship, have endured many toils, and have risked their health, and some even have lost their lives in the service of the forests of India.

It is a cause of thankfulness that scientific and practical forestry is taking a hold upon the public mind in India. The European civil officers of the Government are beginning to understand the subject, and to co-operate with the regular forest officers. Schools of forestry for the natives are being established.

In conclusion, this subject, which I have, I am afraid, imperfectly treated in the brief space of an hour, is worthy the best attention of such a body as the Society of Arts. This Society has influenced Englishmen in many directions, and I venture to say that there are few directions in which the influence of so learned, influential, and practical a Society as this can be more beneficially exercised than in furthering the interests of forest conservancy in India, which is the greatest of the dependencies of England.

DISCUSSION.

Dr. Cleghorn said it had given him great pleasure to hear Sir R. Temple's description of the forests of India, and of the improved management which now existed. In December, 1856, he was called upon to begin at the very beginning, as the first forest officer appointed in Madras; his friend, Dr. Brandis, began his duties in Burmah about the same period. In Bombay the work began a little earlier, but in the north it was not until 1861, and in 1862 the first Forest Act was drafted. Since then the organisation had extended over the whole Empire. He rejoiced very much to hear that the results had been such as they had heard. There could be no doubt that the evils of denudation at the head waters of the large rivers were very great. He had travelled up the Indus, the Irrawaddy, and the Godavery, and of the evils brought out in the concluding chapter of the Famine Commission Report no one who had witnessed them could have the smallest doubt whatever. He had also visited the head waters of the Cauvery and other large rivers which rose in the Western Ghauts, and there could be no doubt of the terrible evils which arose from denudation. He had visited forests in 1855 and 1856, where there were wild deer in considerable abundance, but where there was now not sufficient vegetation to afford them shelter, and they had all disappeared. One of the many causes which led to denudation was the ramification of railways, for in the course of two or three years the demand for fuel alone generally led to an almost total denudation for ten or twelve miles on each side of the railway.

Sir Joseph Fayrer, M.D., K.C.S.I., F.R.S., being called upon, said he had not come at all prepared to take any part in the discussion, but he had been much instructed and interested in what he had heard, and congratulated the Society very much on the communication which had been made by one so well qualified to make it. No governing authority in India had ever done more to foster and encourage the development of science than the gentleman they had had the pleasure of listening to, and he was glad to have this opportunity of paying his tribute of admiration and gratitude for the encouragement which Sir Richard Temple had always given to science in India; he was perfectly certain that sooner or later, all scientific men would endorse that opinion. The subject of the address was not one upon which he was qualified to speak, as he had never been a forest officer, but he had always taken much interest in the question. He had seen a great deal of the forests in India, and had travelled amongst them. If there were one point which he should emphasise more than another, it was one which had scarcely been touched upon, namely, the great importance of these forests upon the health of the enormous population of that great country. That population consisted of 250,000,000, and the country was as large as the whole of Europe, excluding Russia. Although the amount of the rainfall itself might not be much interfered with by the denudation of forests, it was much interfered with as to its distribution. There were large tracts of country in India, especially in the north-west, which were almost destitute of vegetation, and it was of the greatest importance that vegetation should be encouraged in those districts if possible. That was one of the directions in which forest conservancy might be most beneficial. With reference to the question of the denudation of the hill sides, there could be no doubt of its evil results, of which

there were abundant examples in Europe; as, for instance, in Greece, and, perhaps, in Cyprus. You had only to study the sides of that great range of mountains, the Himalayas, which extend for about 1,600 miles from east to west, with an average breadth of perhaps 150, and rising to a height of nearly 30,000 feet, and pouring down from the great water-shed the enormous rivers which run east and south-west, and which would, but for the forests which clothed those hill sides, inevitably carry every year desolation and ruin by the floods they brought down. It had been said that endeavours ought to be made to cultivate the Terai, and take away the vegetation which retained the water, but nothing would be more destructive. It might be, and no doubt was, for a certain part of the year, pestilential from malaria, but if the vegetation were taken away, there would be that disproportion in the distribution of water which would be destructive. That was another direction in which forest conservancy might be well developed. Those who know the north-west provinces of India, who had been at Delhi and Agra at the commencement of the hot season, and who had travelled from there towards the east, knew that when they got within the shadow of the great range of hills, that an extraordinary change of climate was experienced; it was not a question of altitude, but of the moisture which was present in the atmosphere due to vegetation. Sir Richard Temple had referred to one very important point, the destruction of the grass; and he had seen a good deal of that. He had seen large tracks of jungle in flames, and the fire extending into the forests. He had seen large trunks destroyed and, what was far worse, thousands of young trees blighted for ever. The object of these fires was to manure the ground, but it was a most wasteful process; and it was a very wise restriction which the Forest Department had put on their officers, that they should not allow those fires to take place where they could be prevented.

Sir William Robinson, K.C.S.I., desired also to express his thanks to Sir Richard Temple. He thought there was a good deal of imagination in the idea of the arid plains of the tropical India ever having been covered with forest verdure. It had no existence in fact within the memory of man, and could not be re-created. He himself was not so complete a believer in the climatic influences of these forests. He believed that great moisture-laden trade winds of the tropics were arrested by mountain ranges rather than by trees, and Sir Richard Temple had shown that that was pretty much the case. There was, no doubt, a moisture and dewyness about forest land in the low country, but this is all that can be affirmed. He had lived all his life on the west coast, and knew what the south-west monsoon was. It is not influenced by forests. He doubted very much whether famine droughts were created or influenced by woodland denudation. No doubt denudation had occurred, valuable timbers have been cut out and used, but cultivation had very much progressed; and within the 37 years he had been in India, it had much more than doubled. On the west coast it had very largely increased, and of course the forests had disappeared; and he did not think the substitution was a bad one. Exaggeration had characterised the whole argument. He would, however, admit that care must now be devoted to the preservation of forests where they existed; but he did not think the denudation had been anything like so large or wasteful as it was alleged to have been; for there was not a forest district round the circle of mountain ranges in South India, down to the Neilgerries and up to the Bombay frontier that he had not been in. There was a question which had been very little touched upon by the lecturer, and that was the proprietary right over the forest ranges of India. Forests were valuable, they had been valuable for thousands of years, and had been appropriated. Of course no one in that room supposed that the forest ranges of the west coast of India, which had enjoyed a timber traffic of an enormous character with Arabia, Egypt, and the Gulf, time out of mind, was a "No man's land," which could be appropriated by the Government when it pleased. That was not so much the case in other parts, but still most of the valuable forests had been appropriated, and for hundreds of years had belonged to private individuals or communities; and when this forest conservancy began, it was a very difficult question how you could drive alien forest laws (alien to Englishmen as well as to Indians) in amongst the ancients people of India. There were no public forest laws in England. You had to go to Germany, Austria, and the Tyrol to see what forest laws were. They were necessarily meddlesome, and we ought to be very careful how we dealt with our native subjects in this matter. He, himself, had been deeply apprehensive and anxious on the subject, for he knew it was a difficult question, even on the continent of Europe. Usurpations began almost as soon as British administrations came into the country on the west coast; and when what was called the East India Company's monopoly of timber and wood trade was introduced into Malabar and Canara, it was sternly opposed by Sir Thomas Monroe. It was proposed by the Bombay Government to have a conservator of forests there; the experiment was persisted in for 20 years, and the history of that period was very suggestive, and one which made men accustomed to these things very thoughtful and anxious. Happily, after the monopoly had wrought a great deal of harm, Sir Thomas Monroe happened to become governor; he took the question up, and the whole of this evil was swept away in 1822. There was a great temptation to usurp and carry forestry into places where the prescriptive titles were not very clear, and likely to be menaced. He had doubt himself about the wisdom of large State monopolies of forest and timber trade. In the meantime, with the exception of some such things which would require very careful watching, the Forest Department was doing fairly well. He thought, too, that the recent law on the subject was aggressive; it provided a separate establishment for the management of these questions of property and rights; there was a Forest Settlement officer, who had to go about challenging titles, and in Madras he might be as young in the service as four years. Then the appeal was to the Forest Court, created *ad hoc*, not to the ordinary tribunals of the country, which he did not think was wise or necessary, because, from the native point of view, the executive would be less independent; he accepted this view. Again the law was excessively drastic with regard to penalties, and as far as he understood, would enable transit duties to be levied on the timber trade of the country. One thing he was very anxious about was as to the assumption by Government of proprietary right in the village forests. A large portion of India, practically, belonged to the villages, but the new law, as it seemed to him, simply did away with all village property in forests and local woodlands, and was eminently resumptive.

The Chairman remarked that the question which Sir William Robinson was opening was so large that it would require a whole evening to discuss it.

Sir W. Robinson said the Forest Law laid down that there were only State forests and private forests, and practically denied to village and communal forests any existence. The State forests might be put under strict rules, but the old village communal areas ought not to be touched by the State under any circumstances whatever. The rights of the people should be strengthened, not challenged and interfered with by the law or State executive. Forest rules are plaguing the people.

Mr. Wm. Botly said his experience of agriculture in England, and also on the Continent, showed the necessity of maintaining and extending forests. They were not only picturesque but profitable, and would

well pay for planting in belts, even in this country. On the sides of mountains and hills they afforded shelter, both to cattle and also to growing crops; and, if this were true in England, by analogy it must be so in India. Forests also fertilised the land; he knew of land which 200 years ago would produce nothing but heather, but after having been planted with trees, was so much fertilised by the falling leaves, that it now grew excellent corn. He considered that any one who planted trees was a benefactor to posterity. With regard to agriculture in India, he wished the Government model farms were more generally extended, and that agriculture was more generally taught scientifically.

The Chairman said he would not himself trespass upon the meeting more than to say that, while Sir Joseph Fayrer was speaking of the pestilential character of the Terai, it brought to his mind that, when he first went to Italy, forty years ago, the Maremma of Tuscany was quite as pestilential as the Terai of India ever was, but now, thanks to cutting avenues through the woods, and drainage, that pestilential character had almost entirely disappeared. He believed the time would come when even the Terai would no longer be looked upon with terror. He concluded by proposing a vote of thanks to Sir Richard Temple, which was carried unanimously.

Sir R. Temple, in acknowledging the vote of thanks, said he had only one word to add in conclusion. The area which he had presented, of 70,000 square miles of forest, more or less preserved, was held to be the property of the Government, the domain of the State. There might be within the domain certain subordinate rights, which he alluded to in the close of his address as the rights of the people. But outside this area, there would be the vast area of forest, of which he could not give the statistics (which must greatly exceed the 70,000 square miles), which had been allotted to the people, and in which their full right was entirely acknowledged, he hoped even to the satisfaction of Sir William Robinson himself. So that it was not to be supposed that, in preserving the forests, the Government was in any way invading the rights of the people. On the contrary, these rights would be most carefully acknowledged in the vast area of forests left in their hands, an area considered quite sufficient for their ordinary requirements. It was only regarding what might be called the first-rate forests, which had great economic and climatic value, that these important conservancy measures had been undertaken. 70,000 square miles was but a very small proportion of the total area of British India, which amounted to no less than one and a-half millions square miles, so that they had not got much more than 1-25th—hardly more than 1-30th—of the area under forest conservancy; and it would be admitted that, considering the circumstances of the Empire and its reasonable requirements, both economic and climatic, the area under forest conservancy, instead of being too much, was really too little. He hoped that one result of this subject being taken up by the Society of Arts, would be the further development of forest conservancy in India, and the consequence of that policy would be certainly to benefit the natives, for, after all, it was for their welfare that the British Government in India existed.

ADJOURNED ORDINARY MEETING.

Monday, January 24, 1881; Hyde Clarke, Esq., in the chair.

The discussion on Mr. Alfred G. Lock's paper on "Causes of Success and Failure in Modern Gold Mining," adjourned from 19th inst., was resumed.

The Chairman, in opening the discussion, said that he regretted having been unable to attend the last meeting, but he had read Mr. Lock's paper, which was a valuable contribution to one branch of metallurgy. He welcomed Mr. Lock as a fellow-labourer, having himself read a paper before the Society of Arts, on "Copper Smelting," in 1858. The paper which they had met to discuss was one of a thoroughly practical character, and fittingly brought before the Society an account of what has become a recognised department of English metallurgy, of particular importance at the present time. Although the English school had long since applied itself successfully to the working of copper, tin, iron, coal, and other minerals, gold working was a foreign pursuit, carried on by the Spaniards, Portuguese, and Germans. On the establishment of independence in South America, the English began to take a share in the gold and silver mines. In 1824 and 1825, numerous companies were formed with extravagant expectations, and many of which, although working old and rich mines, ended in disaster. A national advantage, nevertheless, accrued from these undertakings. The most intelligent captains and miners were taken from Cornwall and Wales, and they came back prepared to introduce at home still greater efficiency in their business. Abroad they made themselves masters of the native modes of working, and introduced many improvements and far better machinery. The companies, of necessity, were driven to try all kinds of new inventions and processes, and although some of them were of foreign origin, they all contributed to the formation of a satisfactory system. Some of the English companies, as the St. John del Rey in the Brazils, have continued to yield large dividends to this day, while in other cases, though the companies failed, Englishmen remained in Mexico, Chili, and Brazil, working on their own account, or in association with natives, and bringing back large fortunes. Thus originated an English school of gold metallurgy, the work of which was chiefly carried on abroad, and therefore less known. The participation of the English in foreign silver industries was no less successful, and a large business at Swansea has been established as a market for various silver ores, while at Newcastle the process of Pattinsonising, invented by Mr. Pattinson, has enabled workers to treat not only British silver lead ores, but many Spanish ores. The Americans engaged about the same time as the English in gold enterprise, and the discovery of gold in Virginia and the eastern and northern States stimulated them. When the discovery of gold in California, and of silver in that State and Nevada took place, Englishmen were quite able to deal with the business, independent of any foreign help. The discovery of gold in Australia made gold mining an industry and profession within the empire, and the works in the several colonies of that region, and of New Zealand, do honour to the knowledge and intelligence of the population. It is these processes which Mr. Lock chiefly describes with the necessary detail. Few are aware what returns mining in the colonies and foreign countries bring to those at home, apart from any investment of capital. There are the remittances for the sustenance of families, there are the remittances of earnings and savings, and great quantities of machinery and supplies are obtained from our establishments. Mr. Lock's paper comes, too, at a convenient juncture, when the gold mining of India is justly attracting attention, and when the spirit of speculation is promoting operations in Venezuela and Guyana. In reference to engineering and chemistry, gold reduction has the greatest interest, because large masses of mineral have to be pulverised by natural or other mechanical means at the smallest cost to get at a most delicate proportion of the precious metal.

Mr. Smedley repeated the observations he had made on the former occasion with regard to the importance of

an improved system in the management of mines. At the present moment he was engaged in encouraging a system, which he hoped to put into practice in a short time, for the purpose of endeavouring to introduce, on a large scale, what was known as the tribute system, which meant that every one who worked on the mines should be paid by results.

Admiral Selwyn said, that although an admiral in the Navy, he had been connected with practical mining for several years, both in Western America and this country. He had remarked that one of the great causes of the complaints made, that there was so large a proportion of non-dividend paying mines, was the fact that men always looked for rich ore, and took no care of the poor; it was only by impressing on them the necessity of making the last cent out of every ton of ore that that system could be got rid of. The processes pursued in Western America were amongst the most perfect known. Australia had given something to California, but California, in its clever machinery, which had been copied in Australia, had been the main-spring of the work. There were particular processes worked there which were, as yet, unknown in Australia. These were largely chemical processes, and in America, when chemical processes were discovered, the man who discovered them was anxious to keep them secret as long as possible. He was tempted, by the extreme facility by which he could take out a valid patent, to make it known in that way, but he did not propagate it as a man did who is interested in the results of the process. If he were only a patentee, and not a miner, he might look at the royalty rather than the solid results in the mine he conducted. Some miners had invented tobacco juice to be put in the pans, others sugar, salt, clay, and every kind of material almost which could possibly be useless. These things they had not kept to themselves, but where they had found out means of really deriving a larger proportion of silver or gold from the ore than their neighbours, that they kept to themselves as long as they could. He had been both milling and smelting in America, and they generally thought they did very well if they got between 70 and 80 per cent. of the metal in the ore; in fact, they rarely rose to that. He did not say according to the ordinary assays, because they were very unsatisfactory. He had practiced assaying to some extent, and a very little mistake in the man who urged the furnaces while the cupelling was going on would give utterly false results. It was quite possible for a great portion of the silver and gold present, as sulphates, to go up the chimney. In 1873 and 1874, when in Utah, he took out ore which showed 60 dollars per ton by the dry assay, whilst, by the humid process, he took 69 dollars per ton out of it, showing that a large proportion was escaping by the other method. His brother, who was the head of the Geological Survey in Canada, told him again and again that in Canada there were thousands of tons of crushed ore containing sulphurets of gold containing 3 to 5 ozs. to the ton, and yet no one knew how to get it out. In the present state of chemical knowledge, that was simply ridiculous; but the instant you went there and attempted to do it, you were met by exorbitant demands on the part of so-called owners of these refuse heaps, so that a practical metallurgist had very little chance. It was only by the general spread of knowledge, by such means as Mr. Lock's paper, and the discussion on it, that any great progress could be made. The Washoe process, of which he had just spoken, was equally effective in getting gold and silver, since no silver bars came from the Western States which did not contain gold. He had evidence of that in working at the New Consols Mine, near Callington, in Devonshire, where the ore was very poor, and if it could be treated by a simple process, there would be hope for even the poorest gold mines. This ore contained from 3 to 5 tons of silver, $1\frac{1}{2}$ per cent. of copper, and a trace of gold, as the result of a fire assay. The results of 30 tons worked was 196 ozs. of silver, $1\frac{1}{8}$ oz. of gold, 1 ton of copper, precipitate, 70 per cent., worth about £65, so that the total results were about £118 on the 30 tons of very poor stuff indeed. That process was one of roasting in furnaces with salt and, afterwards, of boiling in tanks with salt and muriatic acid. When he was in Utah in 1871, he had never seen or heard of either Anderson's, Longmead's, Augustin's, or Rhodin's processes, but it occurred to him that Nature must have had some solvent to put the metal into its present position, and he found that salt water, with a very small quantity of hydrochloric acid, used to boil the ore, would produce the whole of the contents in metal; further, that where gold, silver, lead, copper, or anything but platinum and tin, were present, it produced it in perfectly clear solution; where arsenic and sulphur were present, a chlorodising roasting must precede the operation. But at this mine in Devonshire, their great error was that they had antiquated roasting furnaces, and that the quantity treated per day could not possibly pay with such a grade of ore. If you had a very low grade ore, it was necessary to treat a large quantity per day, and if any one part of the process failed to give the necessary quantity, the whole broke down. This was one of the first requirements, but it was utterly unknown in this country. Very little known also was the furnace on the plan of Stettefelt, or O'Hara, which Stettefelt would probably say was an imitation of his. That was a process in which chlorodising roasting took place, by dropping powdered ore from the top of a chimney shaft into the flame of a furnace, occasionally fed with salt, or the salt was mixed with the ore. O'Hara did very much the same thing, but with a little less labour. This mine in Devonshire was furnished with self-acting tables, the inside worked by water-power; the rabble being fixed, it turned the ore over on the bed-plate. Stamping was not done at all, but the ore was crushed by a set of rollers, crushing it as fine as they could. In America, they wanted very much machinery which would do something more than the present stamp; and Blake's crusher served the stamps capitally, and always kept ahead, although the stamps crushed two and a-half tons per day per stamp head. In some instances, some improvement had been made by attaching rollers to the Blake's crusher; and he had heard that Mr. Marsden had a new crusher, which would fulfil these conditions. If that could be done, it was the most admirable machine which could be proposed for the mine, because stamps were very expensive, and did not do sufficient for the purpose. If you had a furnace which could roast 100 tons a day, and corresponding tanks into which to work it, either lixiviating or boiling, you ought to have a number of stamp heads sufficient to do that duty, and these stamp heads would cost more than all the rest of the plant put together. Besides that, they were extremely objectionable up at the mines, as they involved steam machinery to drive them, and you had to take enormous boilers for the purpose. He had seen teams of mules, 100 yards long, dragging a boiler up a hill; and the boilers rapidly wore out. He wanted to see a process initiated on a proper basis, with an understanding first of the chemical laws concerned, that the whole thing, no matter whether it was called the Washoe process or any other, consisted in the chlorodising of the mills; that nature, when she put the metals into the rocks, had them first boiling in a hot, salt ocean, with an excess of chlorine. If you reversed that process, you had got the same thing to the last dwt. That could not be done but by examining first the question of the furnace. Stettefelt's was a good furnace, but not the best that could be devised, because you had still to use some fuel and attention, both of which cost money; and as there was sulphur in most of the ores, which required the process

of roasting. Hollway's process ought to have shown that, if oxygen enough were used, the only fuel required was the sulphur of the ore; the arsenic might be recovered again in the flues. Having got a good furnace, the next thing was what to do with the ore. He had always advocated simple wooden tanks. In the mill he was running at Utah, they tried for some time to put in hydrochloric acid besides the salt; they usually put in sulphate of copper, salt, and some other extraordinary chemicals like those he had mentioned. Then they heated it with wrought-iron pipes; the pans themselves were generally made of wrought iron, with a flat basis of cast iron set with dies, and the muller was worked round on their lid shoes, all these being of cast iron. The most extraordinary fact came out. They got an enormous per-centage of the contents of the ore up to 93 per cent. in actual practice, and they got the silver extraordinarily pure; but, unfortunately, every bit of the wrought iron about the place began to yield to the chemical action. The silver was deposited, but it was at the expense of the pans and the pipes; they had to give up the process, unless they could constantly replace them, which was not easy in the mountains. However, an intelligent examination showed that you did not want an iron pan; you did want an iron muller, shoes, and dies, which you expect to wear out; but cast iron was worn much more slowly than wrought iron, and the pan itself could be made of wood and hooped round. In that case you would get all the chemical conditions fulfilled; what wear took place of the mullers and dies, would contribute a fine powdered iron to cause the chemical combination sought. This question of the humid process had been known to everybody connected with mining for many years, but up to 1871 or 1872, they did not give such satisfactory results as were sought, of about 46 to 60 per cent. of the metal in the ore. And he believed he was the first who ever put out anything like 26 per cent. of the metal contained. He took out a patent at the time, but it was hard for one man to fight these things. Unfortunately, everybody tried to make use of it without the knowledge which alone could make it useful. They did it inefficiently, each man taking what he had heard of, and thinking he was very wise, and that he had saved the royalty, the effect being that he made a mess of it to the extent of pounds, where he would only have had to pay shillings. This was a great misfortune, largely due to the state of our Patent-law. With regard to the management of mines, he should have been very glad if he could have run a tunnel in, when he had no hope of getting anything, on tribute; but you could not do it. The men must be sure of their pay, or they would drop their tools directly. You could not sink a shaft, you could not run a level, unless in tolerably rich ore, on tribute. It was usual to let the work on tribute when you had ore, and he always did it; in fact, it had never been the practice amongst miners in Cornwall to do anything else, and all managers of mines were too glad to adopt it when they could. They generally took a stop of which they had not a very good opinion, and said to a man, "We cannot tell what this will give; will you go into a little speculation?" A poor man could not speculate much, but sometimes he said, "I will risk it if you will set it to me at a decent rate; I don't mind taking it with a partner or two." In that way you got tribute work done, to the great advantage of the men sometimes, but at others to the great advantage of the miner; but it was a speculation, and miners could not always afford to go in for that sort of thing. As regards the interest every man took in the mine, he thought a manager's interest was very strongly secured by his pay, because if the mine did not go on and prosper he knew very well it would come to an end, and there would be no more pay for him; it was true some managers did not get paid at all whether the mine prospered or not. He had an assayer retained to assay constantly, or to look at his tools, to study new processes when there was no assaying to do. How could he ask him to work on tribute; you must have *employées*, if only the blacksmith to sharpen the tools, and there would be some day when there would be no tools to sharpen, and you could not send him away. It had been said that the dividend of steamship companies lay in their coal bunkers, and so the question of whether a mine paid a dividend or not lay in making every ton of rock pay as it came out, if possible. That was what he would really impress on everybody connected with gold mining in India, to see that there was no excuse made for anything thrown away. The assayer ought to be a thoroughly trustworthy man, and should assay what went away as well as what came out. If he did not know everything in the rock and what ought to come out of it, he was not worthy the name. When that was done, mines would prosper. There were no doubt many obstacles. Everybody engaged in mining as they did in tallow, sugar, or anything else, but it must always remain a speculation, for he never could discover that any miner could see beyond the length of his pick. Still a great deal of capital would be usefully employed in mining, and to show how largely that was not the case at present, he would state exactly what had occurred in California. Several millions sterling had come out of those mines, but if you took from Professor Raymond, or anybody else, the quantities of shafts sunk and branches and tunnels driven, it would be found that rather more had been put into the ground in the shape of labour than came out of it altogether in the shape of gold and silver, but it had enriched the country, and gave an outlet for agricultural progress, and encouraged the people to come in and settle, and did a great deal of good in many bye-ways, irrespective of the curious balance of which he had spoken. All over the world you will find the same condition of things. If you took the quantity of paying mines, and set against them the quantity of work done which did not pay, it gave about a balance. There had been a recent discovery which promised something, which he might perhaps advert to as a specimen of an idea cropping out in a new shape. A chemist in Paris had recently patented a discovery by which he proposed to get out, without roasting, from ores containing sulphur and arsenic in large quantities, all the gold and silver—not the copper; and he claimed that he had taken out, from the refuse of the Tharsis Company, more gold than they ever knew was in it. He said he used the perchloride of mercury largely, instead of quicksilver, in the grinding process, which he conducted in iron pans, and he used it in salt water. He got iron, chlorine, mercury, and some metals in combination in salt water. He had no doubt that some such effect as he claimed would be produced, simply because that was exactly what they did, in a rough way, in the Washoe process. They put in sulphate of copper and salt; the sulphuric acid left the copper, combined with the salt, to form hydrochloric acid; they had iron pans, so that they were in fact fulfilling the conditions under which per-chloride of mercury could be made, although nobody out there had any idea that that was the manner in which it was done. They all said it was something to do with the nascent copper, or some other wonderful arrangement, and they never sought for the chlorination of this process, considered why it was important, or examined how far the chlorination was carried, because both gold and silver could be carried away in a perfectly clear fluid, and the very water thrown away might, under such conditions, contain as much silver and gold as you were crediting the takings with. When his brother was head of the Geological Survey in Australia, he told him that in mercury troughs at the bottom of blankets he had often found crystals of gold much larger than could have passed through the gratings, showing that there was a formation there, owing to some galvanic action, which deposited the gold in crystals. If that were the case,

you could easily see how a good deal of gold and silver might be lost without its being suspected. If this French chemist had found out the way to get at the gold and silver without roasting first, it would save a great deal of expenditure, and in such a way as to lead up to the true chemical reactions which took place; he would have done an immense deal more for miners than had been done in his recollection by anyone else.

The Secretary said it would be interesting if Mr. Lock could give more information about the sodium amalgamation process, which he had alluded to, and which he believed was discovered by Mr. Crookes. The tone of the paper seemed to be in favour of mechanical rather than chemical methods; but it would be interesting to know if he had any knowledge of this process on a large scale, and what was his opinion of it.

Admiral Selwyn said the process referred to had been largely tried in California, and was now rather discredited.

The Secretary said one of the objections mentioned by Mr. Lock was the fact of this process taking up base metals. That could be readily understood, for sodium amalgamation would coat many metals; it would even give a nice clean coat to quite dirty iron. He was not sure whether experiments in this direction had been made by Mr. Crookes, but he knew they had been by Mr. Bolas. It had been suggested that the process might be very useful for the amalgamation of the zinc plates in ordinary electric batteries, but he did not know if anything had been done in that way. Another point to which he might refer, as likely to interest the members, was the reference to Plattner's chlorination process, which recalled to his mind a passage in the last volume of Dr. Percy's great work, in which he referred to the very beautiful process known as Miller's process for the purification of brittle gold from other metals. This, as Dr. Percy mentioned, was brought before that Society as long ago as 1840, by Mr. Thompson, in conjunction with the then Secretary, Mr. Arthur Aikin. He produced practically pure gold from a mixture of gold, silver, copper, and other metals, by simply passing a stream of chlorine gas over the metals when in a state of fusion. This process was now used in the Sydney Mint for the purification of gold; and if not exactly within the scope of the paper, was interesting as showing what had been done by the Society in former years.

Mr. Fisher, being called upon, said he was not prepared to speak, but he should be glad to show his new crushing machine, which he hoped would be finished in a day or two, to any one interested in the matter.

Admiral Selwyn remarked that Plattner's process was for some time in use at La Doura, in Mexico, but the chief objection to it was that it took twelve hours for a charge, and you could not conduct mining processes in that way. It was a beautiful chemical process, but did not answer practically on a large scale.

Mr. Moon said he had been engaged for several years in gold mining in Australia, and whilst there paid great attention to perfecting the operation by means of stamps, and after all he had seen, he thought there was nothing equal to it, either for speed or the fine pulverisation of the ore. Admiral Selwyn said he thought it good work to get two and a-half tons per stamp-head per day; but he got it without a Blake or any other crusher, and the ore came out through a grating of between 300 and 400 holes to the square inch. The stamp-heads weighed 6 cwt., and the stone was put in as large as it would go into the hopper – as large as one's head. At first they were much troubled to keep down the splash, but at last he hit upon a plan of making the water keep its own water down, and by that means they worked the stamps perfectly dry. He did not agree with Mr. Lock that the outlet gratings should be back and front; it was unnecessary, as the same effect could be produced by using a little more water. If the outlet in front were 12 inches by the width of the stamping-box, you would get it all out. The foundations could not be too solid; and curiously enough, he had found that where water would not go, gold would, for in taking up old stamp bottoms, he had found gold where it was perfectly dry. For amalmagation they used a cradle with a circular back, in which they put the quicksilver, with a small one in front, and the speed was regulated so as just to keep the stuff lively. The action of sand upon crushed quartz, with the quicksilver in water was to give a roughness to the gold, so that the quicksilver could lay hold of it, which it would not do under other circumstances. In practice they never, except from some careless starting of the stamps too quickly, found any quicksilver in the front part of the cradle. Some years ago he was engaged on a gold, copper, silver, and lead mine in North Wales, and put up some machinery there, of a very substantial character. He would show a sample of the lead, and he had a stone now which contained visible gold, copper, and lead, and several other metals. Of course sulphur was present, and arsenic too. The mechanical mercury process there was greatly interfered with, by the great number of metals, which made it difficult to keep the cradles sufficiently lively; lead was very heavy, and it was necessary to adopt an extra mechanical process to keep it from stagnating. For several months he was at work on this mine, and the quicksilver he lost was only a very few ounces out of the 350 lbs. in use, which was practically equivalent to no loss at all, when you remembered that you could not pour mercury from one vessel to another without losing some. The lead contained a considerable quantity of silver, but the company was anxious to make it a gold mine, and nothing else, which he thought was a mistake. The other day he had a new crusher brought to his notice, which seemed very good. The objection to Blake's crusher was that the moving part was worked by an excentric; in the new machine this was replaced by a crank and lever, the friction being reduced one-half. If such a machine were used, or stamps such as he should suggest, weighing about 700 lbs., at least four or four and a-half tons would be crushed per stamp head per twenty-four hours. You could not have the stuff put into the stamps too fine, because you got a greater effect. If you put a 4-inch stone under a stamp which lifted 11 inches, you only got a 7-inch fall, whereas if the stuff was not larger than an inch, you got a 10-inch fall, and, of course, the further the fall, the greater the effect. It was very important that the best machinery should always be put up. He quite sympathised with Mr. Smedley's idea about working on tribute, but practically in many cases it was impossible. There were shafts to be sunk, adits to be driven, and so on, which men would not work at on tribute. If you got a payable ore, very likely men would take it on tribute, but not otherwise. He had known many men who would work for a time on a mine, then go to work for themselves, and when they had emptied their pockets, they would go back and work at the mine. If you could get first-rate machinery, and pay men to work it, they would be quite sufficient inducement without any tribute.

Mr. Sholl said that Mr. Lock had so thoroughly exhausted the subject of modern gold mining in his able paper, that there was little left to be said, but he should like to make a few remarks on the important question of stamping the minerals. He was of opinion that the correct principle of disintegrating any minerals containing particles of varying densities, was by imparting rapid and elastic blows, and by using a sufficient amount of water to get rid of the stamped stuff, the instant it was ready to pass the screens. The diagram of his stamping-machine on the wall showed it to be a modified steam-hammer. If, however, it were a steam-

hammer, it would be the very worst possible machine for stamping ores that could be used, inasmuch as a dead blow would smash the mineral (pyrites) and gold in a manner that would be quite fatal to the latter. The modification consists in the reaction of compressed air in chambers above and below the piston taken in, and expelled through the holes, which cushions the blow at every stroke, and renders it thoroughly elastic in its character, and especially adapted for dealing with materials of varying densities, as at speed any known mineral (including emery stone), must succumb, although still retaining the elastic blow in its perfection, as the harder the blow, the more perfect the cushion. The volume of water required per head for ordinary American quartz is about 400 gallons per hour for each pneumatic head. The guaranteed capacity of these stamps is about 10 tons of hard gold quartz per 24 hours through screens 400 holes to the inch, and with two heads in one coffer about 16 tons. Objections have been raised to the supposed heating of the air by compression and consequent loss, but the fact is, that the air is not heated at all, because the outside of the pneumatic stamp is constantly under the influence of cold running water, which ultimately runs into the coffer.

Mr. Henty said Mr. Lock, the other evening, explained the chemical combination of gold in iron pyrites, but it was always considered to be a mechanical mixture, not a chemical combination. It was also thought that there were no ores of gold. He had just come from America, and had a specimen of telluride of gold from Boulder County. He did not wish to say anything in favour of American mining, except that it was a large field, and that there were a great number of Cornish miners in America. He was glad to hear of the Indian gold fields, and hoped they would turn out successful. They would probably be worked under very different circumstances from those which formerly existed, when the mines were originally discovered. There was now a great deal of scientific knowledge brought to bear on the matter, which would facilitate the proper working of the ores and the extraction of the metal when found in connection with iron and arsenical pyrites. Allusion had been made to low grade minerals, and he quite agreed that many mines had become very profitable, when they were not successful at first, simply by putting up machinery, which enabled them to concentrate and extract the gold from ore which otherwise was not fit for the market. A mine was generally in an out-of-the-way place, far from the facilities one could desire. The first requisite to success was to have a manager really competent in every respect; and a man educated to his profession, who could combine theory and practice, was the best man. One of the first considerations in machinery was portability. Just now it was a question between stamps of various kinds; but it must be admitted that, wherever stamps were employed, they were more efficient if a crusher were used in connection with them. Most mines under companies were worked under contract work, but those owned by private individuals were generally worked under a lease, which was similar to the tribute system. He had known miners start when they first came out, and work for a company, and when they had made a little money their great desire was to find a place where the rock showed traces of mineral, and try to make money on a lease. But, where a company owned a mine, until they had proved the value of it, it was not practicable in the first place, and in the second place it would not be justified in putting men to work on lease in a mine, near to other mines worked under contract. They might be honest men, but it was not right to put temptation in the way even of honest men. There were large quantities of rich ore lying about, as a big blast would bring down two or three tons at a time. Pieces of ore might easily fall out of the bucket or skip, and there was a temptation to the men to put them in their pockets. The mineral was so similar throughout the district, that it would be impossible to say what mine the stolen piece came from. The specimen he produced was very rich, containing from 50 to 100 ounces of gold to the ton, and a consiiderable quantity of silver. A piece broken off the end of that stone he had put into a muffle, heated it to draw off the telluride, and it left the gold thickly covering the stone.

Dr. Carter Blake said he was at the gold mines in Central America for some time, 13 or 14 years ago. The Chairman must remember the fact that there was in Central America a set of savages who employed for the extraction of gold a much more simple method than these which had been described; who employed the *arastra* method, which was simply the rotation of four large stones of coarse sandstone, a system of the most barbarous, imperfect, and irregular character. But what did that system do? It produced a larger per-centage of gold than some of the most improved and exact processes which had been since applied. These mines had been worked by the Spaniards, and by these wretched Indians, to a productive result, at an extremely small expense for labour. Some might say that the saving produced was simply a question of labour; others might say that the expense of carriage and of European mills and machinery was extremely heavy, and that was why they had not paid; but some experience in Central America led him to think of the story in Walton's "Angler," where the little ragged boy, with a crooked pin at the end of a string, landed a bigger fish than the elaborate angler did with the most expensive fishing-rod and apparatus. There was one question he should like to ask practical men, being entirely ignorant on the subject himself, viz., where the miners in Central America got the mercury for amalgamation before the Spanish colonisation. There was evidence that these gold mines were worked, but there was no evidence whatever that the knowledge of mercury existed amongst these Indians.

Mr. Smedley asked leave to explain, with regard to his suggestion for introducing the tribute system, that he did not mean it to apply to dead work, such as sinking shafts, running tunnels, or driving adits, but to the delicate manipulation of the quartz after it is mined, that is, to the crushing, amalgamating, and reduction of the ore into bar gold, and to the subsequent classifying and concentration of the tailings.

The Chairman thought there had been a little difficulty in the description arising from the title of the paper, which was in reality a paper of a highly practical character, dealing mainly with mechanical processes. He had not, at the present moment, the advantage possessed by Admiral Selwyn and several other gentlemen, of being practically connected with these matters, but he might nevertheless be of some use, as he had had that intervention in former years, and it was sometimes useful to bring to bear on such questions the evidence of one who might, perhaps, call himself an interested bystander. They were all apt, in looking at new inventions, to think they were absolutely new, whereas further inquiry showed, as Mr. Trueman Wood had pointed out, that it was but the development of an idea which had been worked at years before. Beyond his own personal experience, which was not very small, he had some acquaintance with the history of the subject, and he knew that, whether with regard to the mechanical or the chemical part, it had in all times occupied the attention of men of very great knowledge and ability. The evidence they had had that evening from many gentlemen as to the way in which they had applied themselves to the subject, was only a repetition of what had taken place in times long past. There were, however, diffi-

culties, even apart from those to which Mr. Henty had alluded. It was easy in the laboratory to deal with the question of reduction; but the real fact was, that there was hardly a district or place in which there was not some special characteristic in the mineral, and we had still greater difficulties in reduction works, which received the ores of various districts. Mining operations were begun, and the reduction was carried on in the best possible way, and it was, perhaps, only towards the end of the time that the little chemical peculiarity was discovered which enabled that description of ore to be successfully dealt with. With regard to roasting, for instance, in some cases, the very roasting of the ore had the effect of impeding the abstraction of the metal. In some cases you exhausted the whole of your mine before you found out what ought to be done with it. This was a difficulty for which managers of mines were by no means to be blamed. The truth was, as Admiral Selwyn had said, that mining must be absolutely a speculation. They must not, however, suppose that while mining was a speculation, and while they had presented to them such figures as those mentioned by Mr. Lock—which he knew to be accurate—that that was a true representation of the condition of mining. It was almost impossible to get at the true facts, considered in their economic conditions. They saw, for instance, £50,000 put down for the capital of a mine; the mine came to an end, and it was assumed that, as no dividend was paid, there was a dead loss of £50,000; but, in economical fact, there was, perhaps, no £50,000 at all. In some cases half of that had been put down as the consideration for the purchase of the mine, or had gone in other ways of the same kind, and represented no efficient disposal of capital. Another thing which happened in mining, over and over again, was this: three sets of companies, or individuals, worked a mine, each sustained a loss, each turned over the machinery to its successor, and the last one made it pay, as in the case of the Devon Consuls, which, with a capital of £1,000, paid a £500 dividend on each £1 share. You must get at the real effectual economical conditions to ascertain the real facts. Still, mining was a speculation; and if it did not answer the purposes of the parties, it would not be carried on. When it did not, the mines were suspended for a time, and then, again, the figures became fallacious. It was true there was an inducement to gambling, and the miner became a gambler in mining, and sometimes, as in South America, a gambler outside the mine, instead of following the process which had been described of going and working for wages, and then having a turn at tribute, and then going back to wages again, it too often happened in some countries that, when he had made money in mining, he too often lost it in cock-fighting, monte, or some other form of gambling. It was a spirit of enterprise which induced men to follow up mining, but, unless they could maintain themselves by it, they would certainly not pursue it. It was needless to say anything more on the question of tribute; Mr. Smedley had explained what he meant by it, and it was a system well known in Cornwall, and all over the world. In fact, there was no part of mining which was not a development of centuries of experience; in some cases, dating even from the times of the Romans, or their predecessors. There were so many points which affected administration, and which it would be desirable, if they had time, to follow out; but, unfortunately, they had not. With regard to per-centage of gold, that was no economical criterion. It might give a greater net return to get out 75 per cent. than 80, for instance. There was, however, one point to be borne in mind in discussing this subject, and that was the great distinction between the operations of an individual and a company, Mr. Henty had told them how an individual did in California, and in the same circumstances the same was done in Cornwall, and other countries. When you came to a company it was a totally different affair. A company could never look after its affairs like an individual. It must have checks of various kinds. As Admiral Selwyn had pointed out, you must have an assayer—you must go on feeling your way by his help; but an individual who had a small working did not burden himself with an assayer; he had a good piece of ground, and worked it out in the best way he could. The position of a company was totally different. It must have, apart from the dead work of the mine, a great deal of dead work in the shape of administration. The same forms must be carried out in the beginning before it was ascertained whether the company would pay or no. It mattered not what it was, in any mercantile operation, wherever there was a number of partners, a totally different system of checks was required to those which would do in individual undertakings. Those things were open to abuse, and the only remedy could be what was pointed out by Mr. Lock, Admiral Selwyn, and others, the application of intelligence, and looking to the character and integrity of those employed. He thought he could answer the question put by Dr. Carter Blake, as to where the mercury came from before the Spaniards went to South America; the only answer being that no mercury was employed at all, and that constituted the difference between the old system of gold working and that inaugurated by the Spaniards. Under the old workings, men could only work for gold where it was visible, and where it could be got at mechanically; they began by working up ingots, and then worked up any rich ores of which there was an outcrop. The lesson to be learnt from these things was, that under the proper application of refined processes they were liable to get a much larger amount of gold in the gross than could be obtained by the old and ruder methods. It was almost inconceivable the small amount of gold per ton with which a mine could be made to pay. It was not necessary to make any defence of Mr. Lock in treating with the mechanical conditions, because they must necessarily precede the chemical or metallurgical treatment. You must first get out your ore, and put it in the state for chemical treatment. In conclusion, he proposed a cordial vote of thanks to Mr. Lock for the very valuable paper he had brought forward.

The vote of thanks having been carried unanimously,

Mr. Lock replied on the whole discussion. He said that at the last meeting a gentleman asked him a question about gold mining in Transylvania, and if he could explain why it was not profitable to the Government. He could not answer that very fully, because the Government only worked one mine there. Of Hungarian gold mines generally, and Transylvanian in particular, he had a very high opinion. There was no fault with the mines, the faults lay in the deficiency of capital to work them, and in the treatment of the mineral for the extraction of the gold. But many of the private mines did pay, and the Government mine also paid a considerable amount. There was no doubt they could all be made to pay much more if properly worked with sufficient capital. He agreed with Mr. Smedley, that they wanted a better system of managing most of the gold mines in which English capital is invested. He was disappointed that Mr. Fisher had not said more about his stamping mill, because it was a new idea, only brought under his notice within the last few days, and there were certain parts of it he liked very much, though there were others he did not like at all. It seemed to him that the speed being 500 or 600 blows a minute was a step in the right direction, but its having no cushion, and having a dead blow, seemed to him at present a fatal objection. Again there seemed no means provided in it of letting the free gold, after it was once crushed out of the ore, get into some place where it would not be smashed. He was in hopes they would have had many persons there who would have gone into the question of fine stamping versus roast-

ing, because there was a great deal to be learnt on the subject, and the sooner they knocked their heads together and got some information out of them, the better. He thought that Mr. Fisher's machine was more fit for dry crushing, which was another point not touched upon, how far dry crushing was superior to wet crushing. He exhibited a tracing of Walworth's aspirator, which was being adapted to extract the material out of the coffer as fast as it was stamped, separating it by gravitation in air instead of in water. All these points had to be considered and discussed. He had with him three samples of crushed ore, one of which had passed through a grating of 900 holes to the inch, another through a grating of 2,916 holes to the inch, and the third through a grating of 4,624 holes to the inch. He should like some of the gentlemen present to take some of the latter powders and rub them in the palms of their hands, when it would feel just like fine flour. He must thank Admiral Selwyn for the admirable manner in which he had treated the subject, and was sure he would not object to his differing from him in several important points. The Admiral told them a great deal about America and American systems. He (Mr. Lock) cared only about the process of treating ores, whether it came from America, Australia, or anywhere else; he simply looked at the system with practical common sense, to see whether there was anything in it or not. Of course, he was liable to error, but he endeavoured to exercise his common sense, and he must say it did not seem to him common sense to crush gold and all the material as fine as flour, and then be at all surprised that the gold went away in the water. With regard to the different processes which Admiral Selwyn had touched upon, they were used for the treatment of ores containing copper, silver, lead, and a variety of other things, whilst his paper dealt only with gold. He did not touch on the Washoe process, because it was essentially a silver process.

Admiral Selwyn said it was available for gold.

Mr. Lock said it was available only for a silver ore containing gold, in his opinion. Admiral Selwyn had said that the Plattner process had been abandoned in America. The same thing had occurred also in Australia, because it did not answer. It answered admirably in Germany, but there was a peculiar combination of circumstances which made it answer there. That was a difficulty with which one had to deal—the varying conditions in different countries. What he had striven to do was to point out a simple method, which was being proved by practice to be successful. This was shown by assaying the tailings every hour or two hours to see how much was going away. That was the only test, but the extraordinary thing was he could not get anybody in America to give him an assay of the tailings. It did not seem to him there were any assays made.

Admiral Selwyn said he had been superintendent of mines out there, where it was done constantly every two hours, and he did not know a single decent mill in Western America where it was not done.

Mr Lock said he could never get them. Many gentlemen gave him their processes; but when he asked where they had been tried, and the result, and what where the assays of the tailings, he never could get such assays. It was not much advantage assaying the ore before treatment, because the amount consisted of that which you got out, and that which went away; all you wanted to know was what went away; and if over five or six per cent. went away, there was something radically wrong. Admiral Selwyn told him that there they only got out 70 or 80 per cent., and that exactly bore out what Skidmore, Hague, Raymond, and everybody else in America had said, they did not get the gold out within about 25 to 30 per cent. Now, in Australia, by the method which he had attempted to describe, only five to seven per cent. was left in the tailings. With regard to this chloridising process, it could not be used in every country, because the materials might not exist; there might be a want of fuel and of salt. In Australia it was found that using salt was very good for auriferous copper ores. Admiral Selwyn told them about a wonderful process for getting gold out of a material which did not show gold by assay. Now, he happened to be talking the other day to one of the most eminent practical metallurgists who had treated thousands of tons of similar ore, and in speaking about different patents and new ideas, allusion was made to one of a similar character, of which his friend remarked, "Ah, yes, that is a wonderful process, they get one and a-half ounces of gold out of a ton of stuff, in which, by assaying, no gold could be found." He said, "How in the world did they do that; surely it must be a swindle." "No," said his friend, "it was not; it was done honestly enough. They passed it over amalgamated copper plates, and these plates had been used not long before for some very rich material; some of the gold from the rich material had stuck on the plates, and then, when they came to clean the plates off, they found the gold; and, of course, a very small quantity in an experiment, makes a very large quantity per ton, and thus they managed to get one and a-half ounces of gold out of ore which contained not one grain." He merely mentioned this to show that you must not always believe a thing was a wonderful success because an experiment or two was made with it, and the assay turned out well. It was only by treating many hundreds or thousands of tons that any process could be thoroughly tested. The process he had attempted to explain had been used for millions of tons, and had proved successful. That was the question with any process, would it stand the test—was it the simplest and the best? With regard to Mr. Moon's suggestion, that only one screen was necessary, he thought that point had been already met, and did not require further notice. Sodium amalgam had been tried in Australia, and had not been found successful. There was a great deal in it no doubt, but it was rather a ticklish thing to play with, and unless you had better educated men than at present, it would not come much into use, though in course of time more might be done with it. The result which he drew from the whole discussion was that the subject was not half exhausted. What they wanted in this country was a Gold Institute, similar to the Iron and Steel Institute; a place at which papers could be read and discussions take place, and at which every man who had an idea on the subject could get it discussed, and thus very soon find out whether he was correct or not. He believed that such an institute would have that effect, and gold mining would take an absolutely fresh start, and you would get more capital invested, because it would be better understood. As far as he was concerned, he was quite ready to hand over to such a society all his books and papers, and he thought he could say he had many books which were not obtainable in England; if others would come forward and do the same, they might get up something really practically useful. With regard to the improved stamps, Mr. Moon did not seem to approve much of them, but there he differed from him. He did not say they were fit for gold mining at the present moment, but with some alterations, they certainly were a step in the right direction. He happened to have some gold ore coming over from Asia Minor, and if Mr. Fisher, Mr. Sholl, or any other gentleman liked to have it to crush in their machines, and let people come to see them at work so as to test their capabilities, he should be very happy to let them have it. In conclusion, he thanked the meeting for the attention they had given to the subject.

The Chairman said in the usual course of things his duty would have been finished, but Mr. Lock had

thrown out a proposition which he was sure his former colleagues on the Council would be willing to promote. He had often urged on his old friends in the copper trade to found a Copper Institute, and with regard to a Gold and Silver Institute there could be no question that it would be very valuable. They could not expect many members at first, and there would be difficulties about it, but if Mr. Lock would address a letter to the Council, he was sure they would lend him assistance, which in the early stages would be of service. They could give him the use of rooms, and save preliminary expenses in various directions. In that way, as Mr. Trueman Wood had jogged his memory, many valuable institutions during the last 100 years had been formed under the fostering care of the Society of Arts, some of which were still at work, doing a great deal of good.

PROCEEDINGS OF THE SOCIETY.

EIGHTH ORDINARY MEETING.

Wednesday, January 26th, 1881; ROBERT RAWLINSON, C.B., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Cole, Alfred Clayton, 64, Portland-place, W.
Cook, Henry, Barrow-in-Furness.
Gibbs, George L. M., 46, Grosvenor-street, W.
Green, Herbert, Tovil-house, Maidstone.
Liardet, John Evelyn, 4, Breakspears-road, Brockley.
Littler, R. D. M., Q.C., 1, Plowden-buildings, Temple, E.C.
Lockyer, George, jun., Beaconsfield-house, Godolphin-road, W.
Lovegrove, James, 18, Urswick-road, Lower Clapton, and Town-hall, Hackney.
Lyte, F. Maxwell, F.C.S., Cotford, Oakhill-road, Putney.
Payne, Septimus, Castle-house, 44, Mildmay-grove, Mildmay-park, N.
Shuttleworth, Joseph, Hartsholme-hall, Lincoln, and Stamp End Works, Lincoln.
Wills, George S. V., The Westminster College of Pharmacy.
Wright, Bryce McMurdo, F.R.G.S., Hesket-house, 54, Guildford-street, Russell square, W.C.

The following candidates were balloted for, and duly elected members of the Society:—

Ameuney, Antonius, 87, Seymour-street, Hyde-pk., W.
Ball, John Ball, F.R.G.S., Carisbrooke-lodge, St. John's-road East, Putney.
Carpmael, Edward, Streatham-hill.
Clark, Mateo, 88, Richmond-road, Bayswater, W.
Crowther, Richard William, 18, Cockspur-street, S.W.
De Villiers, Peter, M.D., Ellora-villa, Silverhill, St. Leonards-on-Sea.
Fell, John Barraclough, The Warren, Torrington, Devon.
Folkard, Henry Tennyson, Wigan.
Gostling, William Kennedy, 8, Gloucester-square, Hyde-park, W.
Herring, John Barnwell, The Grove, Esher, Surrey.
Hill, Robert Martin, 117, Leadenhall-street, E.C.
Klein, Adolphe Louis, Burton-in-Lonsdale, Yorkshire.
Robinson, Robert Alleyne, South-lodge, Cockermouth, Cumberland.
Sawyer, William Phillips, Drapers'-hall, Throgmorton-street, E.C.
Smee, Arthur R., Penrhyn-lodge, Woodberry-down, N.
Standfield, John, 6, Westminster-chambers, S.W., and 44, Lillieshall-road, Clapham, S.W.
Surtees, Colonel Charles F., Chalcott-house, Long Ditton, Surrey.
Tapson, John, M.D., 12, St. German's-place, Blackheath.
Theobald, John Peter, The Chestnut-grove, Kingston-on-Thames.
Thompson, John, Mayor of Peterborough.
Timmis, Illius Augustus, 17, Parliament-street, S.W.
Waterlow, Herbert Jameson, 1, The Avenue, Brondesbury, N.W.
Wiggins, Rev. William, Spring-vale, Tonge, Middleton, Lancashire.
Wilson, Rev. Charles Thomas, Chapmore-end, Ware.
Wood, James, 26, Cross-street, Ryde, Isle of Wight.
Wright, E. G., 330, Commercial-road, Landport.

The paper read was on—

SUGGESTIONS FOR PREVENTING LONDON SMOKE, AND MAKING IT COMMERCIALLY AVAILABLE.

By W. D. Scott-Moncrieff, C.E., F.R.S.S.A.

It is sometimes difficult to account for sudden movements of popular opinion. When once they begin, an element of momentum seems to take the place of the previous inertia, and the new form of social force appears frequently to be directly proportionate to the one which preceded it. We are now in the midst of one of these movements of opinion that is not difficult to account for. The interest which at present attaches to the question of how best to obtain the blessings of an uncontaminated atmosphere, has arisen out of a state of things with regard to smoke and fog, that is recognised as dangerous to the whole community. The work of relating the means to the end has commenced in earnest, and there is every likelihood that, before long, the public will be put in possession of information as to how the problem is most likely to be solved.

Some apology is, perhaps, necessary on my part to those who are at present exerting themselves as specialists in this field of inquiry, for not having laid my proposals before them to the exclusion of other channels. I am sure, however, that if any of these gentlemen were in my place, they would have thought twice before rejecting so favourable an opportunity as the one which has been presented to me. The Society of Arts has already identified itself with this important subject. I trust that further facts and information may be brought to light by this additional discussion, and that they may prove useful to the committees whose praiseworthy efforts are, at present, being exerted for the public good.

The present position of the question renders it far from easy to know how best to deal with it before a scientific audience, who are well informed. Materials which were important contributions a few months ago, have already been assimilated, and no longer lend themselves to the further elucidation of the subject, I trust, therefore, I may be permitted to confine myself to the special scheme which I propose, and I need not say with what pleasure it is that I do so, when I tell you that, although it has occupied my thoughts for years, this is the first occasion upon which I have addressed an audience on the subject.

I wish, first of all, to attempt to make clear to you in a few words what is the present aspect of the question as regards the methods and apparatus employed.

The classification of the methods may be arranged as follows:—

1. Burning bituminous coal at a single operation, by exposing it to the heat of the fuel previously ignited. It is unnecessary to say that this method embraces nearly the whole of the domestic consumption of Great Britain, and a great part of the commercial consumption as well.

2. Separating the gas from a cheap quality of coal, heating it in an apparatus known as a regenerator, and using it without the solid residue.

3. Separating the gas from the coal at a comparatively low temperature, adding the partly coked residue of a previous charge to the fuel in the furnace, and passing the gas through the burning mass.

4. Using coke as a basis, and passing gas through the fuel as a means of supporting its combustion, both coke and gas having been obtained from a gas company.

5. Using fuel from which a certain proportion of gas has been extracted, which is the special subject of the present paper.

As regards the apparatus, it naturally follows the classification of methods or systems, and would far exceed the compass of this paper to describe in any detail. It will be well, however, for me to say something of the more familiar appliances which are in every-day use, and to remind you of certain fundamental principles that are common to the whole of them. As you are all well aware, the combustion of bituminous coal depends upon the combination of certain gases, and of carbon and oxygen at a high temperature. It is also familiar to you all, that the oxygen necessary for this combustion is obtained from the atmosphere we live in. One necessary feature of the process is the creation of a draught, which is obtained, as you all are aware, by the action of a heated column of air in a shaft or chimney. But this invariable accompaniment of combustion is, in the nature of things, associated with a movement, not only of the air, but of the gaseous elements of the fuel, and it is almost inconceivable that the necessary quantities of oxygen can be obtained without this element of rapid movement. The question comes to be then, whether or not the mean velocity of the air and gases necessary to supply the oxygen, is compatible with the time that must elapse in order to obtain the necessary chemical combinations at the point of sufficient temperatures, which is in the body of the fire itself.

Now in the case of freshly added bituminous fuel placed on the top of a burning mass, it is quite certain that the conditions of a draught are inconsistent with complete combustion; and this brings us to a consideration whether or not it is possible to consume bituminous coal perfectly at a single operation, and leads to doubt as to the possibility of using the first method successfully in any apparatus, however ingeniously it may be devised for the purpose. Certain proposed processes are sometimes so inconsistent with the operation of invariable natural laws, that a conclusion on the subject of their failure has the certainty of a complete induction. If an apparatus depended upon its success on the tendency of water to run up hill, as in the case of many of our London house drains, we should be safe to predict its failure. The matter, as regards the complete combustion of fuel at one operation, is not quite in this elementary category, but, to my mind, it is very near to being so.

I am sure many present will sympathise with me in the great difficulty of making clear to others matters that do not contain within themselves all the elements of a complete induction. The induction may be so far complete, as regards oneself, that the mind is forced to a definite conclusion, but the discrepancies may, nevertheless, be the very elements which go to form a popular belief in another direction. I do not know of any better way of illustrating my meaning than referring you to several well-known fields of invention which, at one time, seemed to be altogether open, but which have become gradually closed with the advance of scientific knowledge. For instance, in the early days of steam locomotion, there must have been many persons who thought it presumption on the part of certain engineers to oppose themselves to the principle of the atmospheric railway. It must have appeared to them that it was wrong to predict the failure of science in one direction whilst anticipating its triumphs in another. And yet, I have no doubt, that men did appreciate at that time what was practically a complete induction in their own minds, however difficult it may have been to convey their arguments conclusively to others. Now, I do not know of any problem, at first sight, which gives a greater promise of a simple solution than the burning of an ordinary piece of household coal. The elements of combustion not only seem available, but, up to a certain point, lend themselves readily to a partial solution of the difficulty. Nothing is more easy than to get a fire to burn in an ordinary grate, and nothing is more difficult than to get it to burn in such a way that no smoke shall escape up the chimney. To predict the failure of all appliances for all time coming to attain this object is, therefore, on the face of it, an apparently rash anticipation, and yet there is nothing in the scientific aspect of the problem that suggests any other conclusion to my mind. I am not so much inclined to this opinion because of arguments that present themselves readily as the result of experiments on a small scale, but more from those which may be gathered from the experience of persons engaged in the consumption of fuel on a large scale, where the opportunities for carrying out complete combustion are exceptionably favourable.

Taking the iron trade as a typical example, I may say that all experience in the direction of cleanliness and economy is tending rapidly towards a total abandonment of the attempt to burn bituminous coal at one operation. The appliance which perhaps presents the greatest exception to this rule is the blast furnace. The vast scale upon which the consumption of fuel is carried on in this apparatus, would of itself place it in an exceptional position as affording peculiar facilities for obtaining an intense and constant temperature. Even here, however, the operation is becoming, to a great extent, divided, and the utilisation of the waste gases for heating the air stoves is of itself a

proof that, even with all its peculiar advantages, the hot blast is unable to carry out complete combustion at one operation.

Here is an illustration of a blast furnace of a not very improved or modern type, but which is sufficient to show the immense advantage the apparatus has over anything that one can conceive of in our present state of knowledge in respect of a domestic appliance. The temperature is not only intense enough to melt iron, but it is maintained from one month's end to another with the skill and assiduity of trained workmen. The air is not only introduced in immense volumes by means of powerful blowing-engines, but is heated to a high temperature before it reaches the fuel. The artist has, I think, somewhat exaggerated the volumes of smoke escaping from the mouth of the furnace, but its presence at least shows he was conscious of its existence. Now, as a matter of economy, these waste gases are utilised in the modern practice of iron smelting, but if they exist at all under conditions so favourable to complete combustion, what shall we say of appliances that burn a few pounds of coal at a time under the charge of an overworked housemaid? I am not speaking now of perfect combustion, but only of that fair amount which is consistent with a smokeless chimney.

As regards other departments of the iron industry, the attempt to consume bituminous coal at a single operation is being altogether abandoned. The labours of Dr. Siemens, as embodied in his regenerative furnace, have gone far to bring about a change in the direction of scientific principles, and Mr. Price's furnaces, as now used at Woolwich Arsenal, are also an illustration of improvement that has taken place in the same direction. I shall have occasion to speak of these appliances presently. Now, without saying that arguments drawn from such channels are altogether conclusive, I must say that, along with other considerations, they go far towards the formation of an opinion that in cases where the scale of the consumption is smaller, success will be still more impossible of attainment. As regards the scale of appliances that come under the head of domestic apparatus, I believe that the problem of consuming ordinary bituminous coal at one operation will ultimately be abandoned altogether, but it is beyond all likelihood that it will ever be satisfactorily solved. A few years ago, this opinion would have been looked upon as unreasonable. I have long been convinced that it is a sound one, and this belief is supported, not only by several eminent authorities, among whom I may number Dr. Siemens, but also by the whole tendency of the practical improvements which have been carried out in our great national industries. I believe it is capable of a theoretical proof; but even if this were wanting, I think I am justified in pointing to the present condition of our large towns as a demonstration of the failure of existing appliances. When the vast amount of invention which has been expended upon the problem of the complete combustion of bituminous coal at one operation is taken into account, and when it is considered that not one appliance has ever been altogether successful, I think there is a strong *prima facie* case made out against the practicability of the proposal. If I may be allowed to put the argument as near as possible in the form of a syllogism, with regard to domestic hearths, I might say all bituminous coal requires a high temperature steadily maintained for its complete combustion. Domestic fires are incapable of producing a high temperature steadily maintained, therefore domestic fires are unfit for the complete combustion of bituminous coal. To hold an opposite opinion with regard to the element of temperature is inconsistent with the facts, and to insist on the high temperature being continually maintained is to deprive every citizen of his right to allow his fire to go down when the heat he obtains from it has become excessive. I might quote many authorities in support of these opinions. Even in the case of steam-boilers, where skilled labour is available, and where a high temperature, evenly maintained, is an important point, Dr. Angus Smith shows clearly that it is heat that is required for the complete combustion of the fuel, and that the supply of air in sufficient quantities is comparatively easy. I will suppose the case of an absolutely perfect domestic appliance for the combustion of bituminous coal, and I will ask the inventor of it where the heat has to come from that is essential to the process, when the fire has been allowed to go almost out, and the housemaid adds fresh fuel.

So far, I have tried to put the matter before you as regards temperature, but a moment's consideration of the actual process of combustion will, I think, make it equally impossible to escape from the conclusion to which I have come, even as regards the supply of air itself. Burning coals depend for their incandescence upon the passage of air among their exposed surfaces. In an open brazier, it may pass in from all sides, and underneath as well. So far this is a most favourable condition. but as it passes through the burning mass the oxygen is consumed, and it is impossible to insure that the air does not reach some parts of the fuel in an exhausted state. I have here a simple illustration of my meaning. This common paraffin lamp is so arranged that a current of air passes in close contact with the flame from the wick, and the oxygen is consumed in its passage. I will now suppose that this piece of bituminous coal, which I place over the top of the funnel, holds an analogous place to that which it might assume in the most ingeniously constructed stove imaginable, that is to say, some point at which the air, which has already passed through the fire, reaches it exhausted of its oxygen. The temperature of the lamp flame is sufficient to produce an escape of gas, and upon passing my hand over the funnel this is proved by the pungent smell of the gaseous products. Now you will find, that although the gas is escaping, the conditions are altogether inconsistent with combustion of any kind whatever. Upon striking a match, and bringing it near the top of the funnel, you will see that it is instantly extinguished. I now take a piece of smokeless fuel, and place it over the funnel, instead of the piece of coal. It goes without saying that although there is no more chance of combustion in the one case than there is in the other, still no smoke escapes, and, as far as the atmosphere is concerned, no harm is done.

I might multiply arguments indefinitely; but as time is of importance, I must ask even the un-

believing to accept my conclusions in the meantime, and simply point out that if they are right, the idea of adapting domestic hearths to the complete combustion of ordinary bituminous coal may be abandoned at once and for ever. If smoke were like certain gases that burst into flame at a low temperature when they escape into the air, there might be some chance of obtaining a satisfactory result. But the fact that it does not ignite, even in contact with a red-hot piece of iron, shows how temperature, beyond the capacities of an ordinary hearth, is essential to its perfect consumption. I have here a list of the gases contained in ordinary coal:—

	Manchester gas.		Gas as supplied to Houses of Parliament.
Hydrogen	52·71	....	41·71
Marsh gas	31·03	....	41·88
Carbon monoxide	4·47	....	4·98
Olefines	11·19	....	8·72
Nitrogen	—	....	2·71
Carbon dioxide	0·58	....	—
	100·		100·

Now, some of these gases combine with oxygen much more slowly than others, so that some of them, in the case of an apparatus depending upon a draught (and I know of none in the nature of a domestic appliance that does not depend upon a draught), would be half way up the chimney before the combination was complete.

If these conclusions are right, an immense amount of ground is cleared as regards the solution of the problem, because the knowledge of what will be successful is, in nine cases out of ten, arrived at by discovering what cannot be successful in the nature of things. The conclusion means, in other words, either that the use of ordinary bituminous coal must be abandoned altogether, or that some apparatus must be devised for domestic purposes, similar, on a small scale, to those which have been introduced in our great industries, more especially those in the iron trade, to which I have already referred. This brings us to speak of the second and third methods, and I shall do so in as few words as possible. I do not see how these can possibly be carried out, for the simple reason that on the large scale skilled labour and the means of maintaining a constant high temperature are essential features of complete combustion, and neither can possibly be present with any certainty in the case of domestic fires. Dr. Siemens has hit upon an ingenious plan, by which he makes use of the operations of gas companies to separate the operation of combustion, it may be, miles away from the point of domestic use. This is the fourth method I referred to. By burning coke with gas flames burning through it, he avoids the difficulties of separation as regards the consumer, and carries out a scientific system of combustion at the same time. I propose, however, instead of this, to use a modified condition of bituminous coal, and I will try to show the advantages of doing so. It might be presumption on my part to say that I am the discoverer of this sort of fuel, but I may say that, so far as I know, I am the first to bring it into public notice.

First, I may say that, with regard to anthracite coal, if the principle of smokeless fuel is once recognised and enforced, the stone coal will fight its way, and be of great service, not only as a heating agent, but as a wholesome source of competition as well. It is as a means of saving our smoke and improving our light that I propose the fifth method, and I shall go on to describe it.

About ten years ago I made a series of experiments upon the separation of the process of combustion which led me to think very highly of the class of fuel to which I refer. I placed a small D retort in a common Cornish steam boiler, and by lowering the position of the fire bars, arranged an apparatus for the distillation of gas from the fuel in ordinary use, and after some time had elapsed, I discharged the gaseous contents of the retort into the furnace. In this way I secured practically complete combustion by a separation of the fuel into its constituent parts of solid carbon and hydro-carbon products. The semi-coke that resulted from this short distillation was practically smokeless, and I have since discovered that by treating it with water when hot, as in the case of coke, renders it still more smokeless. So far as I am aware, it is the most perfect fuel imaginable, as it has all the cheerfulness of ordinary coal, with none of the disadvantages arising from the creation of smoke.

I must now ask you to turn your attention to the present condition of London as regards its fuel, and to make an effort to realise how matters actually stand. Leaving out of question the coke which is consumed by the public, I want you to realise the fact that there are about four million tons of coal consumed in London every year. You may conceive of this more readily, as a solid cube, with a base of about 200 yards, built square upon all sides, to the height of the cross on St. Paul's Cathedral. This is what is burned for the purpose of obtaining heat, in addition to the surplus coke sold by the gas companies. Bearing this in mind, I must now ask you to try to realise another quantity—viz., about 2,000,000 tons—used for the purpose of obtaining light. This would be represented by a cube about 140 yards at the base, built up to a height of 430 feet. All this vast quantity is passed through retorts, and, after a large amount of bad gas has been extracted from it, it is converted into cinders called coke. Now, it has entirely escaped observation that the gigantic appliances necessary for treating the one heap of coals on a long extraction, with bad results, is capable of extracting a small quantity from both heaps of coals on a short extraction, with good results both as regards gas and fuel. The fuel would be similar to that which resulted from the experiments I have referred to, the illuminating power of London gas would be approximately doubled, and the aniline dyes and ammonia, and other products of the process of distillation, must be doubled as well.

To those who may be ready to exclaim against the vast capital which will be required to carry out this operation, I will now show you how it is that no additional plant is necessary in order to obtain this result. We will begin by a familiar illustration. Supposing one of the smaller gas companies were to begin to-morrow to advertise and sell coal from which only 3,000 cubic feet of gas had been extracted per ton. The fuel must be cheap to the consumer at 23s. per ton, and thus, to start with, the company would recoup its outlay

for coal, which we will suppose cost them on an average about 16s. per ton. But, in order to keep up its normal production of gas, so soon as a retort was discharged, it would simply need to be charged again. In this manner gas would be coming away from the retort all day long, just as formerly, with a slight loss of time to be allowed for the additional frequency of the charging. As, however, the gas under the proposed arrangement comes off much more rapidly than under the existing system. The supply at the end of the 24 hours would be in excess of that which is obtained from the long extraction, and in this way less and not more plant would be necessary to give the same quantity in a given time. But instead of bad 12-candle gas, they would have 20 or 24-candle gas to dispose of, with double the quantity of bye-products to the good in addition. What applies to the case of one small company would of course apply equally to the whole combined.

I have already trespassed on your time at considerable length, but as there are no doubt many here present who prefer an ounce of practice to a hundredweight of theory, I think it well to tell you that my scheme has already been carried out at Woolwich Arsenal when all other methods had failed to supply the establishment with sufficient light. When I say my scheme, I say so with an important limitation in this particular case, because when I went to explain the proposal to Mr. Wallace, who is one of the most scientific gas managers in the kingdom, I found he had already been in the habit of adopting it. Curiously enough, however, he had never generalised from the facts, and until I pointed out the wide applications of which it was capable, had not thought of it as a means of utilising the smoke of our great cities. During the long winter evenings, the available plant at the Arsenal frequently falls short of the demands that are made upon it. Under ordinary conditions, the supply of 16-candle gas is just sufficient for the purpose of supplying light, and if we take quantity of this to be, say, 100 cubic feet per unit of time, then if 20-candle gas were substituted, the quantity of light would be increased proportionately, that is to say from 100 to 125, in terms of a photometric measurement. Now, not only is this result obtained, as regards the quality of the gas, by simply removing one charge of coals at the end of four hours and substituting a fresh one, but larger quantities of the better gas are obtained, and that for two reasons. First of all, the gas comes off in greater quantities per unit of time on an average short extraction than on an average long one; and the fuel used for heating the retorts being greatly superior to ordinary coke, assists the operation still further. In this way, then, the superiority of the short extraction is proved in all directions. I have here a few specimens of the fuel. No. 1 represents an extraction of 3,000 cubic feet per ton; and if it were used in London, this city would be rendered practically smokeless. I must explain, however, that an experimental retort does not give a fair specimen of the fuel. Measurement by the meter is the only method of guessing at the amount of extraction; but this is by no means a satisfactory test of the equable character of the distillation. That is to say, that the 1½ cubic feet of gas which may come away from 1 lb. of coal in an experimental retort, although a satisfactory test of the extraction being at the rate of about 3,000 cubic per ton, may, nevertheless, have come to a great extent from the outer surface of the sample, leaving the interior both bituminous and smoky. In an ordinary extraction on the large scale, the fuel may be taken as smokeless, and in every way suitable for domestic consumption.

Perhaps, the most pleasant way to conclude this paper would be to draw a picture of the present state of London overcast, filthy, given to fogs, grievous to breathe in, with the London of the future, clear as the tops of the Surrey hills, if the fuel I have been describing were in universal use. I must ask you instead, however, to follow me through a few figures which explain the financial bearing of my scheme upon the community generally.

First, then, as regards capital expenditure, I propose to take advantage of the existing plant of the gas companies. I find they are amply sufficient for the purpose.

Instead of taking 10,000 cubic feet of gas per ton from the coal, I propose to take 3,333 cubic feet, and to pass three times the quantity through the retorts, or any other proportion that may be found most convenient. The result of doing so is startling.

The companies will have double the quantity of by-products they have at present in the shape of tar and ammoniacal liquids; the community will have 24-candle gas instead of 16-candle gas; the fuel resulting from the process will light readily, and it will make a cheerful fire that gives out 20 per cent. more heat than common coal; London would become a smokeless city.

In dealing with the figures, I shall take them roughly, but in such a way that by including a few outlying corporations they could be made absolutely correct.

I take the total annual consumption of coal in London to be 6,000,000 tons. Of this I take 2,000,000 tons to be the annual consumption of the gas companies. The total quantity of fuel used for general purposes I take to be 4,000,000 tons of coal and 1,000,000 of coke sold by the gas companies.

We shall now see what would be the result if we treat the whole of the 6,000,000 tons in the retorts on an extraction of less than three hours, instead of the six hours at present prevailing.

The total quantity of 16-candle gas consumed in London may be taken at 2,000,000,000 cubic feet. This would be at the rate of 3,333 cubic feet per ton upon 6,000,000 tons, the total quantity of coal consumed in London. The residual smokeless fuel would amount to 5,100,000 tons. Of this 1,000,000 tons would be required for the extraction of the gas, leaving 4,100,000 available for the general uses of the community. This has to be compared with the 4,000,000 tons of coal and the 1,000,000 tons of coke already referred to as consumed at present. Now, the smokeless fuel which results from an extraction of 3,333 cubic feet of gas per ton has a heating capacity fully 20 per cent. greater than common coal, and 10 per cent. greater than coke. This gives us the exact equivalents of the 5,000,000 tons of fuel at present in use.

So far the account, as regards the fuel available

for the community balances. We may now deal with the difference in value between 16 and 24-candle gas. As the value of the gas varies directly as its illuminating power, the calculation is very simple. If we take the average price of 16-candle gas to be 3s. 6d. per thousand cubic feet, we shall find the total value of the 20,000,000,000 consumed in London to be £3,500,000, but as we have by my scheme the same quantity of 24-candle gas, the value will be increased to £5,250,000; here then we have an annual sum of £1,750,000 to place to the credit of the system.

Turning now to the by-products: seeing the gas companies, by the new arrangements, would subject three times the quantity of coal to the heat of their retorts during the period when the tar and ammoniacal liquors pass off most rapidly, I do not think I am wrong in estimating the yield at double its present amount. Taking this upon the tar and ammonia to yield 3s. 9d. per ton of coal, we find the total value of these by-products to be, at present, on the supposed consumption by the gas companies of 2,000,000 tons of coal per annum, £375,000. This being doubled under my scheme, an additional sum of £375,000 must be placed to its credit.

But the basis upon which we have hitherto been arguing is that the gas companies under the proposed scheme are getting their coal for nothing. We have been supposing that the community become the purchasers of 6,000,000 tons of coal and hand it to the gas companies. At present London only pays for its general consumption on 4,000,000 tons of coal and 1,000,000 of coke. Let us now suppose that the companies pay the same sum annually that they do at present for their coals; if so, they would pay upon 2,000,000 tons, or an annual amount of £1,600,000, if their coals cost 16s. per ton. From this falls to be deducted the money they at present draw from their sales of coke, which, when taken at 6s. per ton of coal carbonised under the existing system, still leaves a sum of £1,000,000, which they could afford to pay per annum for the use of the 6,000,000 tons of fuel as proposed in my scheme. We will now take the total payments of the community for their coal to be upon 6,000,000 tons, for which we will further suppose they pay at the rate of 16s. per ton first cost. This would amount to £4,800,000 per annum. From this has to be deducted the £1,000,000 contributed by the gas companies for the use of the fuel, also the £1,750,000 charged on the difference between the 16 and 24-candle gas already referred to, also the sum of £375,000 of additional income from the by-products. This would leave a net sum paid by the community for its fuel under my scheme of £1,675,000. Under the present system they have to pay, say 16s. per ton on 4,000,000 tons of coal, and say 12s. per ton on 1,000,000 tons of coke. This makes in all the sum of £3,800,000 per annum. Here then we have a balance in favour of my scheme of £2,125,000 annually. This may be taken as the yearly value of London smoke, which I propose to convert into useful products by the plant at present in use.

I have only, in conclusion, to say one or two words about the efficiency of the scheme as regards the fuel. It lights easily, it gives off no smoke, it makes a cheerful fire, it gives out more heat than either coal or coke, it will be cheaper per heat-unit than the coal at present in use, London would become a smokeless city, and all that would fall to be deducted from the sum of £2,125,000 per annum would be confined to a few items, such as the cost of additional workmen employed in charging the retorts, interest upon additional capital required for transit appliances, and the terms to be made with the gas companies for carrying out the scheme.

I have much pleasure in acknowledging the help I have received from Mr. Wallace, the gas manager at Woolwich Arsenal, and the valuable information obtained from Mr. Field's tabulated accounts of the London gas companies. So far as I am aware, my contributions to the *Builder* and elsewhere are the only writing on the subject of my proposal that has ever been made public. I should say, in conclusion, that I have no pecuniary interest whatever in the scheme I propose.

DISCUSSION.

The Chairman said the lecturer had explained that to consume smoke was a very difficult process, but, in fact, as far as he understood the problem, the only real remedy was to prevent it from coming into existence. Smoke consisted principally of carbon, and required a large proportion of oxygen to be combined with it, and time could not be obtained in a furnace or in the flue. They knew that the most perfect gunpowder manufactured and exploded in the most perfect way possible, was never wholly consumed, but that portions of the grains—sometimes very large portions—were driven out unconsumed. That showed the difficulty of getting carbon into combination with a sufficient quantity of oxygen to produce full combustion. The reader of the paper spoke of Dr. Siemens having proposed a mode of extracting a species of crude gas from the poorer classes of coal, but that it was not intended to be applicable for general purposes. That, however, was a mistake, as Dr. Siemens did intend to supply his gas for all heating purposes to town communities, and a Bill was prepared and taken into Parliament for Birmingham for that purpose. It was to be cheap, and distributed as ordinary gas was, for only purposes for which heat was required. He had also spoken of 16-candle gas being 3s. 6d. per 1,000 feet in London, but the companies in London were going to charge 3s.; one on the Southern side charged 2s. 10d.; the large Becton Company was charging 3s. 3d., and would, no doubt, shortly reduce it to 3s. There had been many complaints during the present frost, which affected the gas in many ways. It reduced its volume by condensation to the extent of 5 per cent., and froze the taps and pipes serving it; the result being that at the London Company Board meeting that day, they had about 2,000 complaints of want of proper supply during last week. The amount of coal said to be annually required for London was four million tons, which would impoverish more than 1,000 acres of mine three feet in depth. If, therefore, they could in any way diminish the enormous and disgraceful waste of fuel going on in this country, they would be doing a great national good. They were now using about 110 million tons of coal per annum, about 100 millions being used in this country, and 10 millions being exported; and it was of the highest importance not to go on exhausting our coal-fields at the present rapid rate. Last evening he spent in company with a very eminent chemist who had studied this question, Dr. Robert Angus-Smith, being chief inspector under the Alkali Act, and he had kindly written him a letter, which he would ask the Secretary to read. He would then call on the meeting to discuss the paper; and he asked them to keep as nearly as possible to the subject.

The following letters were read by the Secretary :—

Local Government Board, Whitehall,
26th January, 1881.

My Dear Mr. Rawlinson,—I feel sure that you will have an interesting paper from Mr. Scott-Moncrieff this evening, but it will do no harm to send you some lines, by no means in opposition, but with the belief that the subject must be viewed in many ways. In my report of proceedings, under the Alkali Act for 1878. I mention a plan, actually in use in Bességes, in the south of France, of making coke by distilling the coal, and saving all the products of distillation. I got the full account, and have had it translated and published. It is said that the coke is better than by air treatment, although some people deny this. Now, I show that if we treated the 15 million tons of coal now used for coke in this way, we should have a saving of $3\frac{1}{2}$ million pounds direct, but the sulphate of ammonia, if used as manure, would add eight million pounds worth of food to the produce of the land. If, however, we treated all the coal in the same way, we should add about 50 million pounds worth of bread stuffs, and might begin to export. The calculation of the amount of food is made from results obtained by Messrs. Gilbert and Lawes, the greatest of all authorities, and is confirmed by letters from them. The value of the tar is separate from that. Part of this must be done. Is any work more important? It treats of a revenue in amount fit for all the purposes of a great nation. The sulphur itself would be of great value, instead of poisoning us in fogs, and hurting us at all times, as much of it would be commercially available. I am trying to stir up some people interested in coke-making. I should like to see Mr. Scott-Moncrieff's plan tried where coke is not wanted, and, indeed, we ought to try every good plan.—I am, yours, sincerely, R. Angus Smith.

Robert Rawlinson, Esq., C.B.

The description of the Bességes plan, referred to, is in a Blue-book. Alkali Act Report, presented to Parliament, 1879.*

London Gaslight Company, Works, Nine-elms, S.W.,
25th January, 1881.

My Dear Sir,—We used 155,468 tons of coal last year, One ton yields ten gallons of tar; one ton yields, say, twenty-five gallons of ammoniacal liquor. Our tar last year was worth £17,814 ; liquor about £14,000. I drew a retort or two some days ago, after the charge had been in two hours. Found it very difficult to draw, the soft coke breaking up before the rake; the smoke, in drawing, was a nuisance. The coke was very friable, was difficult to quench, and would be little more than dust after once or twice handling. Moreover, to carbonise coal to that extent only would require a much larger quantity of fuel than is ordinarily used. I regret very much that I cannot be at John-street to-night.—Yours very truly, Robert Morton.

Robert Rawlinson, Esq.

Mr. Haughton wished to put two questions which appeared to him of some importance, and which he had not sufficient scientific knowledge to answer for himself. If he had followed Mr. Moncrieff aright, the fuel which he proposed was practically identical with that which many years ago was universally used in locomotive engines, before railway companies felt themselves at liberty to pollute the atmosphere. He remembered, when a boy, asking what they did with the gas, when he was told it would not pay to collect it. Whether that was correct or not of course he could not say, but he did know that almost every railway company in England and France had abandoned the use of coke, and he always understood that they did so because it did not pay to use it; and many of the coke ovens by the sides of railways had been pulled down. He should like to know the precise cause of this abolition, because this was an experiment on a very large scale, carried on for a long time. The other question was with regard to the quality of the gas made. It appeared to him that, not perhaps immediately, but in the not distant future, the greater part of the gas consumed in this country would be of a lower illuminating power, but giving more heat, than that now in use; and they must look to the electric light in some form or other replacing, to a great extent, the present mode of lighting. He did not believe this would affect the gas companies prejudicially, but he thought they would have to manufacture a different quality of gas, which would be used for cooking, heating, and as a motive power.

Mr. W. R. E. Coles (of the National Health Society) said there was about to be an exhibition of the various means by which the smoke of London might be prevented; and amongst those means gas would be particulary considered. He might say that the committee had had various recommendations from several gas companies, and on the committee they had a member of one of the London gas companies. The committee had also before it several useful inventions for improvements in the flues of houses; there were also inventions for reducing the smoke from bituminous coal by chemical means, and in particular there were several improved forms of grate for burning anthracite coal for domestic purposes. Since this movement had become popular, anthracite coal had been considerably introduced into London, and in many cases with success. As usual, in all important social matters, the Royal voice had been expressed in favour of the movement, and on the following day, at Kensington, Prince Leopold would preside at a meeting, one branch of whose business would be to consider the atmosphere of London in relation particularly to smoke.

Mr. Wolstencroft said that in 1873, there was an exhibition at Manchester of appliances for the economy of fuel, when his father, who was a clergyman, showed a fire-grate of his own devising. There had been a letter in the *Times* recommending that air should be brought in from outside to supply the fire, so as to prevent draughts in the room, and his father accordingly made a hole through the wall and admitted air from the outside. He found that inconvenient, as it blew the ashes into the room, but that difficulty was got over by fixing a piece of slate in such a manner as to confine the air entirely to the fire. This gave a very good fire indeed, and the combustion was so active, that for six months they used no other fuel than that obtained from a large heap of cinders and ashes at a neighbour's farm. Some hundreds of these grates were fitted in Manchester, but the public did not take them up, and the patent was now run out, so that anyone was at liberty to use it. Ordinary gas coke gave a better fire than coal with this grate, and anthracite coal would burn freely. Indeed, on one occasion, when there was no other coal at the exhibition at Peel-park, his father's was the only fire which would burn.

Mr. Hugh Clements thought the waste of fuel and the smoke of London had got to such a pitch that some means should be taken to lessen it. It seemed to him that the plan now brought forward would do much to abate the present nuisance, but any other means which would attain the same result should also be tried. There was no doubt if the gas companies took up this question, and dealt with it in the manner proposed, it would be a great success, as the quantity and quality of gas would be much increased, and also the by-products. With

* Alkali Acts, 1863 and 1874. Fourteenth and Fifteenth Annual Reports of the Inspection of the Proceedings during the years 1877 and 1878. Eyre and Spottiswoode. Price 2s. 2d. "Manufacture of Coke at Bességes," p. 48.

regard to the consumption of coal in ordinary houses, there was no doubt it was about twice as much as it ought to be; houses were built with no regard to ventilation, which could only be obtained from badly fitting doors and windows, causing draughts. Great economy would be effected if a whole street were warmed by one large furnace, for all such operations were always better conducted on a large scale.

Mr. Engert thought too little care was generally bestowed on the way in which coals were stored; for he found, as the result of many experiments, that dry coal gave the gases out freely and caused but little smoke; when it lay for some time exposed to the air and absorbed moisture, it gave three or four times as much, and when it had been exposed to showers of rain it produced ten times as much smoke as dry coal. Unfortunately, most of the coal in London was kept in cellars exposed to damp and rain, and in one house where he lately went to see an experiment tried, it was so wet it would hardly burn. He had lately been talking a great deal to engineers and stokers on the matter, and they sometimes told him that the wind was very unfavourable to them, though they hardly seemed to understand why it was so. He thought every furnace ought to be so enclosed that the wind would not affect it. A great deal was said about the economy of the fuel for poor people, and he had no doubt that with a good cheap kitchener they might save a large quantity of the coal which now simply went up the chimney. He had an invention of his own, but he would not refer to it on the present occasion.

Mr. Webber said he would endeavour to bring the discussion back to the question at issue by asking Mr. Moncrieff one or two questions. He said that more heat was given out from this partially carbonised coal than from raw coal. If this was weight for weight, he (Mr. Webber) did not exactly see how coal from which a certain weight of combustible had been drawn could possibly give out as much heat as if all that combustible remained in it. Mr. Morton, in his letter, touched a very serious point when he said that he had tried drawing a charge of coal, 1½ or 2 hours after it was put in, and he found great difficulty. He had had some experience in the matter, and he could bear out Mr. Morton's statement in that respect. It was always possible to see in a gas works when the coal was properly carbonised, without going near the retort; for if it came out too soon it made a most tremendous smoke. Unless Mr. Morton's statement could be shown to be wrong, if only one-third of the gas was produced, three times the weight of coal could not very well be burned off, and if that were not so, the existing plant could not do the work. If it was possible to partially carbonise three times the amount of coal in the same time, the case was very different, but from Mr. Morton's statement, supplemented by the experience of every gas manager, he did not think it was altogether clear. He would call attention to the report of Dr. Ballard, who carried out a long inspection of various manufacturing processes where noxious vapours and smoke were given off, and he partially drew attention to the fact that, when coal was not properly burned off in gas works, a very great nuisance was occasioned in the neighbourhood. The present system might be all wrong, but if it were, the gas companies would not be at all backward in taking advantage of any better system that would give them one or two per cent. more dividend.

Mr. Lowson desired to express the great pleasure he had felt in listening to this very able and interesting paper. To him the idea was theoretically perfect, and if it could be carried into effect, he had not the slightest hesitation in saying that London would be smokeless tomorrow. The volatile products were of course now being wasted and sent up the chimneys, and if they could be first utilised, as Mr. Moncrieff had shown, by destructive distillation in retorts, there was no doubt they would all be sources of revenue to the community, and it would clear the air of large towns of smoke. The last speaker had referred to the statement with regard to more heat being given out by this fuel than coal, but that arose from the large amount of heat now being used in volatilising the products of the raw coal. That heat disappeared, and would reappear in the fuel which would be supplied. He had been much struck with the figures given, showing the great economy which had been effected. Assuming six million tons of coals to be consumed annually in London, and taking them at an average price of £1 per ton, that was £6,000,000, on which it was reckoned there would be a saving of £2,000,000. But he did not think account had been taken of the extra labour which would be required to work three times the present amount of coal in the gas works. He had not much hope of the scheme being adopted in London just yet, but if Mr. Moncrieff would go down to Birmingham and read his paper, and could show that a saving of £100,000 could be effected by it, he had little doubt it would soon be taken up.

Mr. Lawry Whittle said that, as a member of the committee of which Mr. Coles had spoken, he had had many discussions with various people as to the best means of preventing smoke. There were several methods proposed, especially the introduction of new appliances and of new fuel, including anthracite and coke; and it was very important that these things should be put before the public in a clear and systematic way, as had been done that evening. He had found anthracite useful, but had not yet heard anything so important as this paper on the question of coke, and he looked to the proposal as one of the most important means of meeting the evil. He was happy to think that the people were beginning to recognise the evil as one within the scope of their own energies to deal with. They had to deal in London with a public of several millions; they could not, in his opinion, deal with them by legislation, but must show them the remedies, and by degrees induce them to adopt them. Mechanical appliances might attract some people, different fuels would attract others, and amongst these, partially coked coal had always presented itself to him as one of the most promising.

The Chairman, in concluding the discussion, said he presumed Mr. Moncrieff would take his coal for coking purposes as new as possible. This was an important point, because gas coal was very volatile, and if it lay on the surface for any length of time, it very rapidly depreciated, from 5 up to as much as 25 per cent. With regard to the value of the waste products, if all the coal now burned in open fireplaces were so treated as to make those tarry and residual products, which now went up the chimneys and only did injury, available as they were in gas works, the result would be astonishing. Mr. Morton, in his letter read by the Secretary, told them that, at the London Gas Works, about 155,000 tons of coal were carbonised per annum, and the realised profits in tar and ammoniacal liquor were £31,814; if they multiplied that by 13, which would bring it to nearly 2,000,000 tons, that would represent a sum of £413,582, which was now sent into the London atmosphere to do nothing but mischief. It was quite true Mr. Moncrieff did not propose to exhaust the coal to the same extent as the gas company did now, and whether that would reduce the volume and relative value of the residual products he was not prepared to say. With respect to the remarks of Mr. Morton as to the difficulty of drawing the retorts, no doubt there would be that difficulty with the retorts, as they were arranged at present, because he knew Mr. Morton intimately, and knew him to be an extremely careful and intelligent man, and, like the reader of the paper, he came north of the Tweed. Whether the process would be the same with partial distillation, whether the apparatus would be

the same, whether the retorts would be the same, he was not prepared to say; but it was quite clear that coke could be made by different processes and in different manners. It was true, as had been said, that railway companies did once use coke entirely for their locomotives; but he did not know that they had abandoned it so much on account of the economy, though that had certainly come into the account; but the first engines were small, and the fire-boxes were also small, so that they could not use coal to raise their steam. They had now enlarged their fire-boxes, and arranged their apparatus so perfectly that they could use crude coal. But they did not formerly use the cheap coke Mr. Moncrieff contemplated, but used a coke made specially, from which all the residual products were turned into the atmosphere, smoke and all, and nothing came out but the bare carbon; which, according to the returns from the gas works, really had the least value. If Mr. Moncrieff intended to preserve all the residuals and give coke as well, he did what the coke makers for railway companies never did. Again, though the old coke ovens were abandoned, the making of coke was not. It went on to a large extent, because it enabled coal owners to turn their small coal, which had little value, into a product which had great value for the purposes of smelting, puddling furnaces, and for steel making, whilst the heat which came from the ovens was not wasted, but was utilised for steam purposes.

Mr. Scott-Moncrieff, in reply, said the most important point, perhaps, raised, was that mentioned in the letter from Mr. Morton, who had evidently made a practical experiment. This weighed very strongly with him; and he had no hesitation in saying, that if his plan were adopted, great skill, very likely competitive skill, would have to be brought to bear in the production of the best form of fuel. One of the samples he had with him, from which 6,000 feet of gas per ton had been taken, was, like that described by Mr. Morton, exceedingly friable; but another sample was by no means so friable. In an experiment such as Mr. Morton spoke of, he believed an exceedingly spongy condition of coal ensued, which, no doubt, would have to be avoided. The tar began to exude; and at that particular stage of distillation the coal would hardly stand carriage at all. It might be that special means would have to be taken by the gas companies; the fuel might be compressed; or it might be treated in various ways. But if the object to be attained was such as it appeared to be the opinion of the meeting that it might be, he had no doubt that the fuel might be made perfectly available for carriage and for use. One sample had been with difficulty withdrawn from the retort; but with the others it was not so. The atomic or molecular condition of the material was exceedingly unstable, and some skill would no doubt be required to produce it to the best effect. The Chairman had already replied fully to the question put by Mr. Haughton as to early locomotives. As to the electric light, there were various views with regard to it, and they certainly could not say whether it would come into use next year, the year after, or in two or three years. If this were really a reasonable scheme for dealing with a nuisance which was affecting the health of the whole community, and it could be carried out at no great expense and without much trouble, even looking at it as a temporary remedy, it would be better to adopt it than to wait indefinitely for a light about which, to say the least, there was a dreat deal of discussion. Mr. Webber asked how the heat in this fuel could be greater than in coal; in estimating it at 20 per cent., he had spoken without exact information, but Mr. Lowson had pointed out the explanation of the present anomaly. If you took a piece of coal and a quantity of water, to turn that water into steam required an enormous quantity of heat, and the condition into which the water was converted was the thermal equivalent of the change. Just the same with the coal; it required a considerable amount of heat to convert it into gas, and there was a thermal equivalent in the one case the same as in the other. By treating it in an open fireplace, the appearance was very cheerful, but an immense deal of heat was absorbed in the process. It was for the same reason that the wick of a lamp was not consumed. It was very near the flame, which was at a very high temperature, and yet it was not consumed—except very slowly—because between the flame and the wick the process was going on of converting the oil into the gaseous constituents, which represented the thermal equivalent, and kept the wick practically cool. A difficulty had also been suggested with regard to the smoke, but that was really a matter of detail, which would be very easily dealt with. A large funnel could be easily arranged over the mouth of the retort, with an exhaust fan which would carry off the smoke, and the men would be better off than at present, the smoke, of course, being taken into the furnace. He had not, as Mr. Lowson supposed, overlooked the question of additional labour, though he had not gone into it in detail, as it was difficult to estimate exactly. He believed it would approximately amount to trebling the number of men employed, in which case perhaps £100,000 might be expended.

The Chairman then proposed a vote of thanks to Mr. Scott-Moncrieff, which was carried unanimously.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

February 2.—"Trade Prospects." By Stephen Bourne.

February 9.—"The Present Condition of the Art of Wood-carving in England." By J. Hungerford Pollen. Sir Philip Cunliffe-Owen, C.B., K.C.M.G. C.I.E., will preside.

February 16.—"The Participation of Labour in the Profits of Enterprise." By Sedley Taylor, M.A., late Fellow of Trinity College, Cambridge.

February 23.—

March 2.—"Flashing Signals for Lighthouses." By Sir William Thomson, LL.D., F.R.S.

March 9.—"Improvements in the Treatment of Esparto for the Manufacture of Paper." By William Arnot, F.C.S.

March 16.—"The Manufacture of Aërated Waters." By T. P. Bruce Warren.

March 23.—"The Increasing Number of Deaths from Explosions, with an Examination of the Causes." By Cornelius Walford.

March 30.—"Recent Advances in Electric Lighting." By W. H. Preece, Pres. Soc. Tel. Eng.

Dates not yet fixed:—

"Buying and Selling; its Nature and its Tools." By Prof. Bonamy Price. On this evening Lord Alfred S. Churchill will preside.

"The Discrimination and Artistic Use of Precious Stones." By Prof. A. H. Church, F.C.S.

"The Compound Air Engine." By Col. F. Beaumont, R.E.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

February 1.—"The Industrial Products of South Africa." By the Right Honourable Sir Henry Bartle Frere, Bart., G.C.B., G.C.S.I., D.C.L., LL.D. Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L., will preside.

February 22.—"The Languages of South Africa." By Robert N. Cust.

March 15.—"The Loo Choo Islands." By Consul John A. Gubbins.

April 5.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

February 24.—"Deep Sea Investigation, and the Apparatus used in it." By J. G. Buchanan, F.R.S.E., F.C.S. Captain Sir George S. Nares, R.N., K.C.B., F.R.S., will preside.

March 24.—"The Future Development of Electrical Appliances." By Prof. John Perry.

The meeting previously announced for April 7 will be held on May 12.

Indian Section.

Friday evenings, at eight o'clock:—

February 11.—"The Gold Fields of India." By Hyde Clarke. Sir William Robinson, K.C.S.I., will preside.

March 4.—"The Results of British Rule in India." By J. M. Maclean.

March 25.—"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Second Course will be on "Watchmaking," by Edward Rigg, M.A. Three Lectures.

Syllabus of the Course.

Lecture I.—February 7.

Introduction—Units of Time—Historical Sketch—Description of usual forms of watch—Escapements—Conditions of accurate timekeeping, and arrangements necessary for their maintenance in the higher class of watch.

Lecture II.—February 14.

The ordinary watch—Degree of accuracy required in it—Systems of manufacture in this country and abroad—Description of specimens illustrative of the various stages of construction—Comparison of the several systems.

Lecture III.—February 21.

Necessity of efforts to promote the art in this country—Need of education, theoretical and practical, in horology—Literature—Great want of uniformity in gauges, screws, &c.—Exhibition of ordinary and complicated watches, and of watchmakers' tools—Conclusion.

The Lectures will be illustrated by Specimens, Models, and Diagrams. The different movements, &c., will be shown enlarged on the screen by means of the Aphengescope and the Electric Light.

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

March 7, 14, 21, 28.

The Fourth Course will be on "The Art of Lacemaking," by Alan S. Cole. Three Lectures.

April 25; May 2, 9.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

May 16, 23, 30.

Admission to Meetings.

Members have the right of attending all the Society's meetings and lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

Monday, Jan. 31st...Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. E. Delmar Morgan, "A Journey to Semiretchia and Kuldja in 1880."
British Architects, 9, Conduit-street, W., 8 p.m. Mr. C. Purdon Clarke, "Persian Architecture and Construction."
Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. T. B. Sprague, "The Construction and Use of a Series of Select Mortality Tables to be used in connection with the Institute. Hm. (5) Table." Parts II. and III.
Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Rev. Mark Pattison, "The Thing that might be."

Tuesday, Feb. 1st...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) The Right Hon. Sir Henry Bartle Frere, Bart., "The Industrial Products of South Africa."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. A. Schäfer, "The Blood." (Lecture III.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion upon "Deep Winning of Coal in South Wales." 2. Mr. Charles Colson, "Portsmouth Dockyard Extension Works."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Biblical Archæology, 9, Conduit-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.

Wednesday, Feb. 2nd ... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. Stephen Bourne, "Trade Prospects."
Geological, Burlington-house, W., 8 p.m. 1. Prof. P. M. Duncan, "The Coralliferous Series of Sind, and its Connection with the last Upheaval of the Himalayas." 2. Mr. P. Herbert Carpenter, "Two New Crinoids from the Upper Chalk of Southern Sweden."
Entomological, 11, Chandos-street, W., 7 p.m.
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. Prof. Redwood, "The Weights, Balances, and Measures Employed in Pharmacy, the Errors which are Liable to Occur in Using them, and Means by which the Accuracy Required in the Weighing and Measuring of Medicines may be Promoted."
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. W. H. Butcher, "Exploration of the Roman Villa, Bromham." 2. Dr. Phené, "Recent Excavations in the Mounds of the Troad, &c."
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m. Annual Meeting.

Thursday, Feb. 3rd...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. George Bentham, "Notes on Cyperaceæ." 2. Dr. Francis Day, "Observations on some British Fishes." 3. Mr. Wm. Biddie, "Remarks on the Coffee-leaf Disease in India." 4. Dr. M. C. Cooke, "Coffee Disease in South America."
Chemical, Burlington-house, W., 8 p.m. 1. Drs. Dupré and Hake, "The Estimation of Organic Carbon in Air." 2. Mr. M. W. Williams, "The Action of the Copper Zinc Couple upon Nitrates."
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. R. H. Scott, "Three Years of Daily Weather Forecasting."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. Francis Hueffer, "The Troubadours." (Lecture III.)
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. W. C. Street, "Draining and Embanking with regard to River Outfalls."
Archæological Institution, 16, New Burlington-street, 4 p.m.

Friday, Feb. 4th....Royal United Service Institute, Whitehall-yard, 3 p.m. Colonel T. Lynden Bell, "The Offensive-Defensive, by Infantry in Extended Order."
Royal Institution, Albemarle-street, W., 9 p.m. Dr. Andrew Wilson, "The Origin of Colonial Organisms."
Geologists' Association, University College, W.C., 8 p.m.
Philological, University College, W.C., 8 p.m.

Saturday, Feb. 5th...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sidney Colvin, "The Amazons." (Lecture III.)

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FRIDAY, FEBRUARY 4, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

EXHIBITION OF 1851.

The Council have had under consideration the question of erecting a memorial on the site of the Great Exhibition of 1851, and have decided that it would be very desirable that such a memorial should be erected. The following letter was sent to the Secretary of the Commissioners of Public Works, who has replied that the Chief Commissioner (the Right Hon. G. S. Lefevre) would receive a deputation from the Council on the subject:—

23rd December, 1880.

Sir,—The Council of the Society of Arts have directed me to request you to inform the Commissioners of Public Works that they consider it highly desirable to record, by a monolith, the site of the Great Exhibition of the Works of Industry of all Nations, held in 1851 in Hyde-park, and they propose to raise the necessary funds by a public subscription, a task in which they expect no great difficulties. It is necessary to seek the consent of the several official authorities, and when that has been secured, to obtain the sanction of her Majesty the Queen.

The Council therefore apply for the permission of the Commissioners of Public Works, to place in Hyde-park, near the spot where the Queen opened the Exhibition on the 1st of May, 1851, a Monolith in granite or other durable stone, with suitable inscriptions. The design, treatment, and execution of such Monolith would, of course, be subject to the approval of the Commissioners.

The Council have deputed Mr. F. J. Bramwell, F.R.S., V.P.Inst.C.E., Chairman of the Council; Sir Henry Cole, K.C.B., a Vice-President; and Mr. Owen Roberts, M.A., one of the Treasurers of the Society, to confer with the Commissioners on the subject, and, in view of carrying the design into effect, to seek permission to use the ground.

The Nation, in respect of Arts, Manufacturers, and Commerce, and general civilisation, has derived the greatest benefits from the Great Exhibition of 1851, which has already been the progenitor of many International Exhibitions in all parts of the civilised world; and there seems every probability of the continuance of them.

The Society will appeal with confidence to the public for the funds necessary to make a memorial worthy of the object, and likely to last for many centuries. Everybody must feel a pride that this country was the originator of the first International Exhibitions, and especially the hundreds of thousands of individuals who have derived direct personal benefit from them.

I have, &c.,

H. T. Wood, *Secretary.*

A. B. Mitford, Esq.

In accordance with the appointment made by Mr. Mitford, on Monday last, the 31st January, a deputation, consisting of the Chairman, Mr. F. J. Bramwell, F.R.S., Sir Henry Cole, K.C.B., Dr. B. W. Richardson, F.R.S., Mr. Owen Roberts, M.A., and the Secretary, had an interview with the Right Hon. G. J. Shaw-Lefevre, M.P., the First Commissioner of Works, and Mr. A. B. Mitford, the Secretary of the Board. The deputation discussed the question with the First Commissioner, who stated that if he could be satisfied an adequate and suitable monument could be provided, he would be prepared to recommend that permission should be granted for its erection on the spot in Hyde-park, where the Great Exhibition building stood.

The Council will endeavour to raise subscriptions for the purpose, and will submit a more detailed scheme to the First Commissioner of Works, as soon as they are able to come to a decision upon the precise character it is desirable the monument should take.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The Council, at their last meeting, resolved to make a grant of £160 to the National Training School for Music, in answer to the application from the School for a renewal of the four Scholarships founded by the Society.

LABEL FOR PLANTS.

The Council are prepared to award a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary not later than the 1st May, 1881.

The Council reserve to themselves the right of withholding the Medal and Prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

PROCEEDINGS OF THE SOCIETY.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Friday, January 27th, 1881; J. C. Stevenson, M.P., in the chair.

The paper read was on—

A NEW MECHANICAL FURNACE, AND A CONTINUOUS SYSTEM OF MANUFACTURING SULPHATE OF SODA.

By James Mactear, F.C.S., F.I.C.

The manufacture of sulphate of soda — or "salt-cake," as it is termed in the alkali trade—is, as a branch of chemical industry, second only to that of sulphuric acid in importance. It is the first stage, so to speak, in the production of alkali, or "soda ash," and bleaching powder, articles which are essential in most of the industries of our country.

The process is a very simple one. Common salt is mixed with sulphuric acid, and the mixture is exposed to heat in a furnace, the resulting products being sulphate of soda and hydrochloric acid gas. In practice, however, the process has various drawbacks, the escapes of gas, more or less in amount, are very annoying to the workmen, and the labour is severe.

During the early days of the alkali manufacture, the operation of "decomposing" the salt was conducted in a small furnace of the reverberatory class, and all the acid vapours were allowed to escape into the air through the chimney. As the trade or manufacture grew in importance, and the quantity of salt decomposed rapidly increased, the damage to crops and vegetation generally, and the great nuisance occasioned by the evolution of the acid gases, caused such complaint, that measures of some kind or other were adopted by all manufacturers to lessen the amount of acid gas escaping. Many ingenious plans were tried with more or less success. That of Mr. Gossage, however, rapidly proved its great superiority over all the others, and it is now adopted by almost all manufacturers of alkali.

While the gaseous products were thus being dealt with, constant endeavours were also being made to improve the construction of the furnaces, but not with the same complete success as in the condensation of the acid gases. These, even so early as 1820, had become such a source of nuisance that we find a patent actually taken out by a Mr. Ford, with a view of carrying on the operations connected with the decomposition of salt "on board a flotilla at sea, at such a distance from land so that the gases may not reach shore."

It will be interesting to follow the gradual changes which have been made in the form of, and manner of working, the furnaces from time to time. Originally the furnace employed in Great Britain was a simple reverberatory furuace, and in it the salt and acid were mixed on the brick hearth, and the acid fumes allowed to escape with the products of combustion into the chimney. As a considerable draught could be used with this furnace, the workmen say that they were rarely incommoded by the acid gases.

After the invention of the bleaching-powder process, by Charles Tennant, in 1799, the chlorine was produced from a mixture of salt, manganese, and sulphuric acid, until about the year 1823, when a system of decomposing the salt in furnaces, and condensing the hydrochloric acid in water, came into use. In the first instance, large iron cylinders were used, and the condensers were made of earthenware pipes, and packed in some cases with flints or pebbles. About this time also furnaces with two beds or divisions were introduced, these having been previously used in France, where already, in 1816, the firm of Chaptal and D'Arcet were condensing their hydrochloric acid and utilising it in the manufacture of gelatine from bones. Amongst the old papers of my firm there is an interesting series of letters from the above-named gentlemen, in which, under date of 1816, they say they were then working 44,000 lbs. per day of crude soda (black ash), of 20 per cent. to 21 per cent. alkali, and were using salt produced at Marseilles by the evaporation of the sea-water, the consumption of sulphuric acid being stated as 83 per cent. on 100 salt.

In the gradual alteration of the furnaces from the simple reverberatory with single bed, the first change was a mere alteration in form of the single bed, which was made circular in form and dished out into a basin-like shape. This furnace was used for a number of years, and went under the name of the "Dandy furnace."

The following extract from an old paper on the manufacture of salt-cake, is interesting:—

"The muriatic acid is the alkali manufacturer's bugbear, proving an intolerable nuisance to the neighbourhood, if allowed to escape into the air, and being exceedingly troublesome to condense perfectly. When salt-cake is made in such furnaces (the Dandy), the evolved muriatic acid is so intermingled with air and smoke, that its complete separation is nearly, if not quite, impossible. The only method is by passing the mixed gases over an extensive surface of cold water; but this, if carried on sufficiently to condense the whole of the acid, would, by cooling the air, destroy the draught; in practice, therefore, it can only partially succeed. The greater part of the acid may be withdrawn, and the nuisance thus materially lessened; but some must still escape, and prove, to the neighbouring farmers' annoyance, that the remedy is ineffectual."

The next stage in the development of the salt-cake furnace, was its construction with two beds instead of only one, as previously used. The first, or decomposing bed, being at one time formed with a leaden pan, lined with brickwork, while the roaster bed was bottomed with brick alone. In a short time the leaden pan was replaced by one made of cast iron, built up in plates, and likewise lined with bricks, and this form of furnace was used somewhat extensively for several years. On May 8th, 1837, however, Thomas Bell patented a furnace which introduced the muffle principle; the furnace, or oven, as he calls it, had only one bed, was constructed with an iron pan, protected both outside and inside by brickwork, and arched over with a double arch, so that the fire gases, after first passing through a series of flues underneath the bed or hearth, passed over the top between the two arches, so that both bottom and top heat were secured.

The idea was apparently quite a new one, and it was speedily improved upon by J. C. Gamble, in 1839 (March 14th), who proposed the use of three divisions, ovens, or retorts, one to be used as the decomposing or mixing portion, and each of the others alternately were to receive, and finish the charge from the first division when it had been stiffened up. Lee almost immediately afterwards introduced a form of open furnace, in which a cast-iron pot or pan was employed, spoon-like in form.

Gamble again improved upon this form of pan, and ere long a furnace with two roasting beds, and a round shallow pan heated by the waste heat from the roasters passing over it, was in use.

From this point invention seems to have been directed into two channels, first, towards the production of the largest amount of strong muriatic acid, leading to the development of the close or muffle furnace, and second, towards the cheapest means of producing salt-cake—leading to the development of the open roaster, or ordinary Tyne furnace.

The close roaster furnaces are those now chiefly used in the Western district and in Scotland, while the open furnaces are more generally used in the Tyne and Eastern district generally.

The muffle furnace now in general use varies much in its dimensions, construction, and general design; a few of these varieties are shown in the diagrams now on the wall, but within the past year or two very great improvements have been introduced into the construction of these furnaces by Messrs. Muspratt, Gamble, and Deacon, who have all aimed at so arranging the combustion of the fuel as to obtain in the flues a pressure rather than a draught.

In Gamble's most ingenious arrangement, gaseous fuel is employed, the air for its combustion being heated by passing through a nest of iron pipes placed in the flue, so that the waste heat is to some extent utilised, while a considerable amount of upward pressure is obtained in the flues of the furnace.

Deacon, on the other hand, obtains the same result with ordinary fuel, by sinking the fire-grate some depth below the floor line, and taking advantage of the power of the ascending column of fuel gases. This furnace has had considerable success, and has reduced very much indeed the leakage through the arch of the furnace, a fault all muffle furnaces are very liable to have.

So much for the close or muffle furnaces. The other class, the open roaster or furnace, has not been so much improved in its old form. The most approved form is that with an iron pan and one "roaster," the pan being heated by a separate fire, and in many cases the roaster being fired with coke, so as to avoid the choking up of the condensers with soot.

In all these various forms of furnace to which I have called your attention, the operations are conducted by means of manual labour, which is severe enough in itself, but which is rendered much more so by the amount of acid vapours which the workman have to bear with, more especially when discharging the furnaces, and which render it much more difficult to replace this class of workmen, than those in almost any other department of an alkali work.

From this cause, the idea of employing mechanical arrangements instead of manual labour was one that very early presented itself to alkali manufacturers, and I have here a drawing of one of the first attempts to carry out this idea, which was tried in or before 1842.

The arrangement of machinery for operating chemical furnaces patented by Pattinson in 1848 was the first real step in the direction of reducing manual labour, and, although it was not so successful as was anticipated, it has helped to show the way to more perfect appliances.

It is true that towards the end of his specification he points out, as regards the usual form of decomposing furnace with pot and roaster, that his apparatus was only suitable for the roaster; but at the beginning of his specification he distinctly points out the application to a decomposing or salt-cake furnace with a single bed, where the salt and acid "are heated, with constant stirring, until the muriatic acid is driven off, and it has become sulphate of soda," and his claim is also clear upon this point. Little more seems to have been done until Jones and Walsh took out their patent in 1875 for a form of furnace consisting of an iron pan of a circular form, which formed the bed of the furnace, upon which the salt and acid were mixed and stirred by scrapers and ploughs, operated, as in Pattinson's furnace, by a central shaft.

The special feature of the patent of Jones and Walsh was a return to the old class of furnace with a single bed, and the doing away with a large amount of the manual labour. It was hoped that this furnace would have been a great success, and a considerable number were erected; but most of these have been, more or less, failures, chiefly owing to the great wear and tear of the machinery, and consequent heavy cost for repairs. Whenever these furnaces have been worked at anything like their alleged capacity, the breakages have been a constant source of trouble, and only when they have been worked lightly have they been at all successful. In some few cases they have been steadily worked for considerable periods without any serious breakdowns, but in these cases there has been great care taken never to overwork them, thus keeping down the heat, and saving tear and wear.

The mechanical difficulties have, it is believed, been, to a considerable extent, overcome in the more recent furnace, patented by Jones and Walsh, in March, 1880, which is constructed almost entirely on the principle of the Mactear calcining furnace, patented in May, 1876, and which is now well known and extensively adopted. But the greatest objection of all to the system adopted by Jones and Walsh—and which holds good equally with the new form of their furnace—is, that the salt and acid being all added within a comparatively small period of time, there is a great evolution of muriatic acid gas at the beginning of the operation, and a rapidly decreasing amount as the process continues. The following figures show the above fact very clearly:—

Furnace charged with KCl.

Commenced to charge at 9.30 a.m.

Do. do. 10.30 ,, with vitriol 150° Sw.

Vitriol all run by 1.0 p.m.

First sample, taken so soon as charge thoroughly mixed.

,, ,, at 1.30. ,, ,,

Table showing decomposition each hour.

1.30 p.m.	contained	24	°/₀ KCl.	=	72·70 °/₀	Decomposed.
2.30 ,,	,,	22	,, ,,	=	75·35 ,,	,,
3.30 ,,	,,	14	,, ,,	=	85·13 ,,	,,
4.30 ,,	,,	9	,, ,,	=	90·60 ,,	,,
5.30 ,,	,,	4	,, ,,	=	95·92 ,,	,,
6.30 ,,	,,	3·6	,, ,,	=	96·32 ,,	,,
7.30 ,,	,,	2·4	,, ,,	=	97·57 ,,	,,
8.30 ,,	,,	1·2	,, ,,	=	98·80 ,,	,,

The temperature of the gases entering the condenser, after passing through 300 feet of piping, ranged between 174° Fahr. at 10.15 a.m. to 110° Fahr. at 7.15 p.m.

Great care is necessary in working the condensers when all the acid is required to be high strength, say 30° to 31° Twaddell. The amount of water running into the condenser having to be altered many times during the progress of the charge, a wash-tower of some sort is needed, before allowing the gases to pass to the chimney.

One feature is well worth noting; there is a very considerable reduction in the amount of vitriol required for the decomposition. This, of course, applies to a greater or less extent to all mechanical furnaces, as the mixture of the salt and acid is not only more rapid, but more complete than it can ever be in hand-worked furnaces. The amount of this saving is stated by various manufacturers who have tried these furnaces of Jones and Walsh to be from 4 per cent. to 5 per cent. on the vitriol used. Various other patents have been taken out for mechanical arrangements, but none of these call for much attention, except that form of furnace or apparatus invented by Cammack and Walker, which, introducing as it does a new phase of the question, is well worth careful study. To these gentlemen belongs the credit of first proposing and carrying out the continuous decomposition of salt in a muffle furnace, although the mechanical difficulties connected with their apparatus have as yet proved too much for their complete success.

The apparatus consists of a cast-iron cylinder, about 20 ft. in length, heated externally by a series of carefully-arranged flues, and made to revolve on bearing-wheels. The salt and acid are fed in at one end continuously, and forced onwards by a screw and scraper arrangement, mounted on a shaft which passes through the cylinder, the passage of the materials through the cylinder being also assisted by its being laid with a slight incline (like Oxland's calciner for ores); the finished sulphate of soda is delivered at the lower end of the machine, and, the hydrochloric acid gas being not at all diluted by air or fuel gases, is very easily condensed.

Great hopes of this furnace being an entire success were entertained; but, after a considerable expenditure of money and a lengthened trial, it has been given up, the mechanical difficulties having proved too great so far.

Therefore, it will be seen no thoroughly satisfactory furnace which will produce sulphate of soda mechanically had as yet been introduced, but the question was one that called urgently for solution. On careful consideration of all the various systems proposed from time to time, and believing that a continuous method, such as is indicated in the animal charcoal revivifying process of Norman and others, and applied to salt-cake by Cummack and Walker, was the proper direction in which to work, I abandoned a series of attempts which I had made to produce a mechanical muffle furnace, and determined to work out the problem of a continuous salt-cake furnace on the open roaster principle.

The conditions with which a mechanical salt-cake furnace must comply in order that it may be successful, are much more stringent than in the case of any of the other furnace operations of an alkali work.

In designing a furnace the following points must be (amongst others) carefully considered and provided for, otherwise there is great likelihood of failure and expense:—

1. Simplicity and strength of the mechanical arrangement.
2. Convenient access to all wearing parts to facilitate repairs.
3. Economy in working.
4. Freedom from escape of acid vapours.
5. Simple delivery of finished sulphate of soda without escape of acid vapours.
6. Simplicity of arrangements for regular feed of acid and salt.

The experience gained from several years' working of the "Mactear" carbonating and calcining furnace, which has been so completely successful in dealing with the question of calcining soda-ash or alkali by mechanical means, pointed at once to the suitability of its general design as a basis for the construction of a salt-cake furnace.

It required, however, a long period of time and many abortive designs and plans, ere the various details were worked out, so as to give reasonable grounds for belief that all the necessary points had been attended to, and provided for, and that there was good ground for belief that the finished furnace was likely to be successful.

The furnace, patented in November, 1879, and shown in the diagrams, has been the result of my attempt to solve the problem of a mechanical salt-cake furnace, and it has been successful. The general construction is very much that of the "Mactear" carbonating furnace, being a circular pan resting on radiating arms, which carry bearing wheels, on which the furnace revolves, the wheels running on a race or rail, and the whole being kept from working out of truth by a central pivot or bearing; the furnace is covered with an arch, carried on a curb piece, supported on a series of pillars, and the emission of acid gases is prevented by a lute, which surrounds the iron pan.

The bed, however, of the furnace, differs from the "Mactear carbonator," in that, instead of having a central opening for discharging the furnace, there is a small iron pan or pot, which first of all receives the acid and salt as they are fed in to the furnace. The flow of acid is constant, and is regulated by a slide and equilibrium valve of simple construction. The supply of salt is intermittent, being regulated by a screw, supplied from a hopper kept filled with salt, the screw being operated by a ratchet wheel, driven by a connecting rod, and a lever and pall, capable of accurate adjustment as to length of stroke, gears into this wheel, so that the amount of feed given to the screw can be governed with the greatest ease.

The salt and acid being continually fed into the centre pot, this becomes full, and the excess flows

over the edge into the bed. This may be either arranged in concentric rings or, as in my later patent, be without division. As the feed continues, the materials gradually work outwards, until the outer edge of the furnace is reached, when the sulphate, now completely finished, falls down through a series of ducts into an annular channel, which is closed by a cover bolted to the furnace and revolving with it, and which works in lutes so as to prevent the escape of gas; the sulphate, as it falls into this channel, is caught by scrapers, and swept round to a large box or hopper, from which it is drawn out into waggons or barrows.

The materials are mixed and turned over by stirrers, ploughs, or scrapers, placed, as in the Mactear carbonator, between the two flues, through which the acid vapours and products of combustion pass away to the condensers, where they are protected to a great extent from the heat.

The bed of the furnace is lined with fire-brick, boiled in tar, and set in a special cement, which becomes harder than ever when subjected to the action of the heat and sulphate, the whole bed settling into one compact mass, which resists very perfectly the action of the materials put into the furnace.

The heating of the furnace may be carried out as most convenient, either coke, coal, or gaseous fuel being used; care must be taken, however, that thorough combustion is attained, so as to prevent soot being passed on into the condensers, as it is not only wasteful in fuel, but apt to stop the condensers up.

The great advantage of a continuous plan of decomposing salt is to be found in connection with the condensation. The flow of water need not be altered for days, as once set for a given quantity of salt and strength of acid there is little likelihood of its requiring to be altered until some change takes place in the quantities being worked.

There is no difficulty in getting all the hydrochloric acid condensed at a strength of 28° to 30° Tw., without any wash tower, and with an escape in the chimney of much less than the Alkali Act allows. There is thus no weak acid produced, a great point gained with a furnace of the open principle, and one which places it at once on a level with the close or muffle furnaces, in which this production of strong acid alone is the great advantage. The amount of condensing plant also is very much less with the new furnace, in fact, not so much as one half what has been found necessary with the close or muffle furnaces now in use.

The salt-cake, as it is withdrawn, is almost entirely free from smell or acid vapour, and there is no trace of gas to be seen about the furnace itself while working. The appearance alone of the salt-cake has been found almost sufficient to enable the workmen to regulate with great nicety the feed of sulphuric acid. The results of the testing of average samples made on each shift for a week (see Table next column) will show this.

These samples were taken by lifting a shovelful from each barrow, as it was filled ($3\frac{1}{2}$ cwt.), and mixing; a small sample was taken from this in the usual way, every two hours, and tested. The above results are the average figures for each shift.

There is no difficulty in making, from common white salt, sulphate of 97 per cent. guaranteed, and the great difficulties which have hitherto pre-

Shift.	Tons made.	Acid (free).	Salt.
1	9·63	1·60	·30
2	8·92	1·25	·65
3	10·33	1·00	·30
4	8·22	1·10	·60
5	9·98	1·50	·40
6	9·62	1·50	·50
7	10·50	1·33	·50
8	8·75	·90	·583
9	10·33	1·25	·40
10	10·15	1·06	·583
11	10·32	1·20	·60
12	9·10	·80	1·40
13	10·15	·90	·50
14	8·23	·75	·60
	Total. 134·23	Average. 1·15	Average. ·565

vented the use of ground rock-salt in the ordinary furnaces altogether disappear with this furnace, as it works rock-salt perfectly, and with it turns out a greater weight of finished sulphate per shift, of a quality which need not contain, at any time, more than $\frac{1}{2}$ per cent. of undecomposed salt.

The quantity of work done depends, to a great extent, upon the draught. In the case of the furnace now at work at St. Rollox (which is connected to a small chimney with little heat in it, so that the draught is exceedingly bad), the work done is about 135 tons per week of seven days—nearly 10 tons per shift; this with common salt, with about 7 per cent. moisture. With a better draught, one ton per hour will be easily finished from common salt with this furnace, which is of 21 ft. outside diameter. Deducting the area of the small pan, and of the outer ring, say 12 in. broad, there remains as a calcining bed about 231 square feet, which, finishing at the rate of one ton per hour, would give about 10 lbs. per hour as the amount calcined per square foot.

The quality of the salt-cake is completely under control; it can either be produced in a fine, powdery condition, suitable for glass-making purposes, or it can be produced in cohering masses, which are more suitable for alkali-making, as, in this form, it is less liable to be carried over into the pan or chimney by the draught.

The sulphate produced is in a condition highly suited for the manufacture of alkali, as it is altogether free from the hard semi-fused lumps such as are too often found in salt-cake made in ordinary furnaces, more especially of the open roaster class. These lumps are very difficult to decompose perfectly in the ball furnace, cause the charge to take a longer time to finish, and are often found as kernels of undecomposed sulphate.

In comparing the relative costs of working the new "Mactear" furnace against the old form, the question of salt-supply is an important element; whether it has to be elevated from the floor level into the hopper of the furnace, or, on the other hand, it can be brought in on the higher level, and be dropped direct into the hopper. In the first case, supposing the salt has to be delivered on the floor level, as happens to be the case with the furnace at present working, then the cost of elevating will be included in the cost of the motive power of the machine.

Assuming, therefore, that in the case of both furnaces the salt is laid down on the floor at the furnace, the actual amount of labour required is, in the case of a Tyne open furnace of most modern construction, furnishing 68 tons of salt-cake per week of six days, three men per shift, or a little more than 11 tons per man per week. In the case of the "Mactear" decomposing furnace, one man per shift is able with ease to do all the work of the furnace, or about 72 tons per week per man, calculated on one ton per hour. In addition for each two or three furnaces, one man is required to look after the engines and oil machinery, and at same time look after the condensers (which require very little attention). In all, the labour may be called 1½ men per shift, or half the number required for the old furnace, while the output, being more than doubled, reduces the actual amount of labour per ton to about one-fourth what it is with the old furnace, the sulphate in each case being drawn into barrows or waggons ready for removal.

The amount of fuel so far has been about 4 cwt. of coke per ton of finished salt-cake; with improved draught it is expected this will be still further reduced.

The actual saving in labour, fuel, &c., after calculating liberally for depreciation of plant and interest, will amount to about 2s. 6d. per ton of salt-cake made from common salt, while to this will fall to be added, in the case of rock-salt, the actual difference in cost of the salt itself.

The effect of such a reduction, when calculated out on the cost of bleaching powder, is sufficiently striking. Assuming that 55 cwt. of salt are required to produce the acid for one ton of bleaching powder, or equal to, say, 60 cwt. of salt-cake, the actual saving would be 7s. 6d. per ton of bleaching powder, common salt being used; with rock-salt, there will be the extra cost of the salt to add to this.

The results and advantages of the new furnace may be summed up as follows:—

1. Greatly decreased cost of the salt-cake produced—say 30 per cent. saved in manufactnring costs.

2. The actual manual labour is much reduced, one-fourth the number of furnace-men being sufficient, while, as they have not to contend with the escapes of hydrochloric acid gas which are met with in the old furnaces, a class of workmen can be employed much more easily dealt with than the ordinary decomposer, who is rather apt to give trouble, and is not easily replaced.

3. The feed of salt and acid being continuous, so is the flow of acid vapour to the condenser; the supply of water can, therefore, be constant, and does not require much attention. The amount of condensing space required is very much less than with the old furnace (about one-half or less), and the acid can all be made of 30° Twaddell if required, without the use of a wash-tower.

4. The quality of the salt-cake is more uniform than that made by the old furnaces, and is completely under control.

5. Rock-salt is worked quite as easily as common salt in this furnace; none of the difficulties which are found in the attempts to use rock-salt in the ordinary furnace, or the danger of breaking the pots, are met with, and the salt-cake is quite as well decomposed; besides, as the rock-salt is free from the moisture present in the common salt, a larger output of salt-cake is obtained.

6. Much less ground is required for the erection of these furnaces, and less roof space is, of course, necessary, while the whole is easily controlled by the foreman, whose duties are much more readily performed than where he has to superintend a series of small batches.

7. Should it be considered desirable, a mechanical draught can be used, and complete condensation effected.

A group of, say, six of such furnaces, each capable of turning out some 150 tons per week of salt-cake, fed from a high level salt-store by means of such simple mechanical means as the travelling belt, used in grain stores, which shall deliver the salt into the service hoppers, the finished salt-cake being discharged into waggons, which shall be run direct to charge the revolving black-ash furnaces, is what I hope ere long to see at work.

These would be worked at a very low cost; and if driven from either one or two main engines, could be worked with one foreman, one engine-man, and eight workmen at most per shift, and in addition to the economy in cost, the great advantage of a works absolutely free from the irritating fumes of hydrochloric acid common to the present style of furnace would be obtained.

I am now preparing plans for such an arrangement, and trust ere long to see my ideas carried out.

DISCUSSION.

The **Chairman** said he had no doubt Mr. Mactear would be willing to give any further explanation of his furnace which might be desired. He should like to ask in what condition the salt and acid mixture was when it left the central pot—was it in a fluid state, and had the decomposition commenced?

Mr. Mactear said the salt and acid came over in a state of mechanical mixture only; little or no decomposition having taken place. It was in very much the same state as the snow at present in the streets, in fact a sludge. In reply to a question how the mixture was moved from the centre to the outside of the pan, he said the furnace was constantly revolving, and there were a series of stirrers, which turned the stuff over. As the feed came from the centre, unless it passed out at the edge, the furnace would get too full.

Mr. Alfred Allhusen asked what was the form of stirrer; it did not appear on the drawing.

Mr. Mactear said he had not attempted to give all the details fully, because the invention was still to some extent in embryo.

Dr. Alder Wright had listened to the paper with great interest, but he should like to ask one or two questions in connection with the construction of the apparatus, more particularly in reference to the scrapers, which he had almost said were the weak point of the machine, on account of their liability to break and get out of order. He understood that it was not yet perfected in that respect, or he should have asked how long the scrapers would last, without its being necessary to stop the continuous process for the purpose of rectifying them, because that was the practical point which really limited the continuousness of the process. Of course, if the works were carried on for only six days in the week, it would be essential to stop once a week, and the repairs could be carried out then; but in works where the process was carried out absolutely continuously, it would be desirable to have some notion

as to the length of time the pan could be kept continuously revolving, without the intermixing arrangement getting so far out of order as to deteriorate the purity of the product, by the material balling together in lumps; or for such other differences as had proved disastrous in the case of Jones and Walsh's arrangement. He should also like to ask if there was any possibility of the diffusion of acid vapours underneath the furnace.

Mr. Charles Thomas (Netham Chemical Works) asked if Mr. Mactear had yet had sufficient experience to say what the cost of repairs would be per ton of salt cake?

Mr. Mactear replied in the negative.

Mr. R. C. Clapham congratulated Mr. Mactear on the very able paper he had read. He felt some difficulty in saying much on the matter, as there were so many present connected with the chemical trade who were better qualified to deal with it. They were much indebted to Mr. Mactear for the attempt he was making to bring about a mechanical decomposition of common salt, which they would all agree was what those in the chemical trade had been aiming at for many years. They knew that Mr. Mactear had succeeded remarkably well in both the balling-furnace and the carbonating furnace, and, therefore, they were bound to receive his remarks with considerable respect. The history he had given of the chemical trade, he found rather a difficulty in entering upon it, as he could go much farther back than quoted by Mr. Mactear, for he recollected when salt was decomposed in leaden furnaces, and the many difficulties connected with it. Coming to more practical matters, there could be no doubt at all that the real point for consideration was whether the Mactear decomposing furnace differed substantially from the Jones and Walsh furnace. He recollected several years ago trying a number of experiments with Jones's furnace, and, as Mr. Mactear had said already, when it was worked for some time, the success was really very satisfactory, especially in the condensation of hydrochloric acid.

Mr. Mactear said he must have been misunderstood; he did not think Jones and Walsh's furnace was successful in this respect.

Mr. Clapham said his opinion was that it was very successful in condensation; he was not at all over-estimating the matter in saying that 20 to 25 per cent. more hydrochloric acid could be condensed by the Jones and Walsh furnace, than by the ordinary hand-worked furnace. It was very gratifying to find that Mr. Mactear could condense the hydrochloric acid without any weak condensers, or anything of that kind. He was not quite sure whether he understood Mr. Mactear to give the heats of the gases as they passed from the furnace to the condensers, and from the tops of the condensers into the air. There could be no doubt, however, that whether Mr. Mactear or Mr. Jones ultimately succeeded, what was really wanted was a mechanical furnace to work the salt.

Mr. Allhusen asked if Mr. Mactear's experience showed that any difficulty arose from the action of the acid on the brickwork on the point between the brick bottom of the roaster and the pan.

Mr. Clements thought from what he had heard to-night, this furnace appeared to be the best of any hitherto constructed. It appeared much simpler than Jones and Walsh's, and the centrifugal action produced, by which the sulphate of soda was gradually sent forward and collected, was much superior to anything that had been done previously. The means of collecting the sulphate of soda made it a continuous process, which had not been accomplished before, whilst, as they had been told that, by the analyses of the substance produced, the quantity of acid could be regulated to a degree of accuracy never before attained. If he could carry out the improvements spoken of in his concluding remarks, by which the salt could be continuously supplied in the same way as the acid, it would almost approach perfection. He hoped he would be able to do so, and by that means no doubt the furnaces would be extensively adopted. He should like to know if Mr. Mactear used this furnace himself, and what was the quantity of sulphate of soda turned out. At the present time there were about 200,000 tons annually manufactured, and as this furnace would turn out 150 tons per week of salt cake, it would require about 1,000 or 1,200 of these furnaces to manufacture the whole quantity produced. It was always a difficult matter to get a new invention taken up, however perfect it might be, on account of the expense of introducing new machinery, but if this furnace were a genuine success there was no doubt that in time other manufacturers would adopt it, and the old ones would disappear.

Mr. Gamble said it was of great importance in the salt cake manufacture to make the process a continuous one, and no doubt Mr. Mactear would find there was a great saving in the condensing plant required, and probably also in the quantity of vitriol used. He should also like him to explain his seventh reason for considering the furnace an improvement, in which he said that should it be considered desirable a mechanical draft could be used and complete condensation effected, but he had already said that he could condense the hydrochloric acid completely.

Mr. Mactear said it was condensed to a lower point than was required by the Act, but with a mechanical draught actually complete condensation would be attained.

Mr. C. Lomas asked if Mr. Mactear did not find considerable difficulty in the caking of the salt cake, as it fell from the furnace into the troughs and ducts, because this would lead to a great difficulty in treating those substances in manufacture. It had always been found a difficulty.

Mr. Mactear, in reply, said Dr. Wright referred first of all to the scrapers being the weak point. To begin with, in the case of Jones's and Walsh's furnace, the scrapers and the shaft were the moving part of the machine, and that principle was radically bad, because the very weakest part of the machine was made to bear the greatest resistance, so that it required the shafts to be of enormous strength. In his furnace, scrapers of any form might be used, and he was still making experiments on this point, but those he now used were very much like the ordinary stirrers of the carbonating furnaces. They were small in diameter, fixed at the end of shafts, which came down and revolved in the furnace. They had very small resistance, and the risk of breakage was very small. He did not remember in his experience of carbonating furnaces, any instances of a stirrer breaking.

The Chairman said he had known such cases.

Mr. Mactear said he had never heard of any, though of course they wore away. In the present furnace the stirrers next the pot, which was working in the strongest acids, wore away rapidly, and one about the middle scarcely wore at all, and the one working the edge in the finished sulphate, wore away a little. The quantity of work which could be done with them was certainly very large. For a wear on the end of the scrapers of about 1½ in., they had finished about 1,000 tons. The furnace had only been at work for about seven weeks in all. It had been repeatedly stopped to make slight alterations; and it was only since the new year it had been kept at work steadily. He did not think there would be any necessity for stopping for any serious repair for a long time to come, and a scraper could be put in in three-quarters of an hour. It only need be stopped while the scrapers were lifted out; it could then be started again without it; and as soon as the scraper was ready, and

hoisted up, it might be again stopped, the scraper dropped in, and in about 10 or 15 minutes operations resumed.

Mr Gamble asked how the scrapers were made to deliver the material to the outside edge of the furnace.

Mr. Mactear said many people seemed to find a difficulty in understanding that; but it arose from this fact, that, there being a continuous flow of salt and acid, and a constant overflow, if the furnace did not deliver the stuff, it would get over-full and choke. But, partly from the centrifugal force, it did not get too full. The delivery of the furnace was absolutely an overflow. That was the principle on which he had worked; basing it on this idea, that, if he fed in the middle, it must get too full and overflow somewhere. They found it to be a mistake to attempt to force the stuff out, because then there was a danger of having the unworked stuff passing over. Dr. Wright also spoke of the works going on regularly for seven days; he did not know what was the habit in Lancashire, but in Scotland, and on the Tyne, they were not in the habit of running for seven days without stoppage. With regard to the corrosion of the iron work, there was absolutely none. The whole of the iron work was painted and tarred; the lute was filled with oil or tar, and there was no escape of gas there at all. The only escape of gas which took place was from the sulphate drawn out from the hopper, and, if it were properly finished, the amount of gas which came off was infinitesimal; in fact, with sulphate, such as was made last week, there was no gas given off. During that week, they had been repeatedly getting the amount of undecomposed salt down to ·1 per cent., and on average of 85 tons it was ·223. The cost of repairs was, of course, a difficult question to answer, and he could not say positively without further experience, but he thought he had discounted that pretty well when he had taken it at double the cost of the carbonating furnace. The only difference was that they had in addition the central iron pot, which did not seem to wear at all, for a hard crust of sulphate half an inch thick formed round it, which apparently protected it perfectly from the acid. All the other arrangements were the same as in the carbonater, except the lute. The wear and tear on the stirrers was of course greater than in the case of the carbonater, but in assuming the repair to be double he made a perfectly fair allowance, because it must be remembered that the carbonating furnaces were doing, possibly, 100 to 130 tons, whereas this furnace would do easily 150 tons, so that if you had double the rate per ton, it more than doubled the absolute amount in money. The lute was made of iron and filled with tar or tar oil. Mr. Clapham spoke of the Jones and Walsh furnace, and said their own machinery much resembled it. His impression was that it was quite the other way. The original Jones and Walsh furnace was the one shown on the drawing, patented in 1875. In 1876 he patented the carbonating furnace, of which the present furnace might be taken as an imitation, except that that was not discharged from the centre. In November, 1879, he patented this new furnace, and in March, 1880, Jones and Walsh patented their new furnace, which resembled this one. The feature of Jones and Walsh's furnace was that they added the whole charge of salt and acid at one time, which he believed to be a radically bad principle, so far as the condensation of hydrochloric acid was concerned. The feature in his was, that it was an open mechanical furnace, working continuously, and giving up the hydrochloric acid in a slow continuous stream, which could be very easily condensed. In reply to Mr. Alhusen, he would say there was no difficulty at all with the joints between the pan and brickwork. After a short time they got a crust of sulphate formed on the whole of the brickwork, the edge of the pan under the bed got covered with a protecting coating of sulphate of soda, which acted very perfectly in protecting both iron and brickwork from corrosion. It was quite true, as Mr. Clements had said, that the centrifugal action assisted the outward direction of the sulphate. He also spoke of ultimately succeeding, and obtaining a continuous feed of salt in the same way as the acid, but that was not absolutely required. They had it practically, for they found, by having a ratchet wheel with pretty close teeth and a pawl which geared into them, and a lever to regulate the number of teeth to be caught by the pawl, which would force it round a given distance at each time, and so give a definite level to the screw which fed in the salt, they got a series of deliveries of so many pounds of salt at a time, which practically was a continuous feed. As to decomposing all the salt in the country, he was afraid that any patentee who should be sanguine that his furnace was going to be adopted by everybody in the trade would find himself very much mistaken. His firm intended to adopt the furnaces themselves, as they believed them to be a thorough success; and, if so, he was quite sure other people would follow. The number that might ultimately be erected was a matter for the future. The saving in oil of vitriol was one on which he could give very few definite figures as yet, because you had to consider the amount of moisture in the salt and the amount of decomposition; but, as far as he could say at present, the saving was about 3 per cent. of sulphuric acid over the amount used in the close furnaces. As to mechanical draughts, the question had been put whether this could be worked in that way. He believed it could, but, if so, the quantity would be considerably reduced, and, as the amount of condensation without appeared exceedingly satisfactory, he did not think it at all likely any one would be anxious to use a mechanical draught. The caking in lumps of the sulphate was a thing they had not been troubled with at all. Sometimes the furnace got into a peculiar condition in which lumps were formed, but they exfoliated and fell down almost to powder when they reached the hot region of the furnace towards the outer rim. The sample shown, which was an average of a week's work, would show that there were no lumps to incommode anybody. In another sample there were a few lumps, but they could very easily be crushed.

The Chairman said they must all feel very much indebted to Mr. Mactear for his valuable paper, and the presence of so many gentlemen from different parts of the country interested in the alkali manufacture was a proof of the interest his paper had awakened. This was another illustration of what seemed to be the revolutionary period of the alkali trade. Some years ago they were under the impression that Mr. Jones had solved the problem in this difficult matter of decomposing furnaces, and they were all pretty sanguine that the Jones furnace would be universally adopted within a few years. Mr. Mactear had explained how these hopes had been disappointed, and that there was still room for the application of enterprise, mechanical skill, and chemical knowledge in solving the problem of an effective decomposing furnace. They must give Mr. Mactear credit for his courage and enterprise in carrying out what he feared must have been costly experiments in striving after perfection. There was no doubt that the continuous process was the thing to aim at; it possessed all the advantages which Mr. Mactear had claimed for it in the regularity of the product, no doubt in economy of material, and certainly in the facility of condensation, because the regular emission of the muriatic acid which had to be condensed was the most essential condition of complete condensation. He should also think it extremely likely that the process would be attended by a saving of acid. This paper was a contribution to a very interesting question which arose in all departments of industry, viz., the limit of the economical application of machinery. Some one had

said that it would never pay to get a machine to pick up stones off a field and put them all into one corner; but that was an extreme case. The real problem Mr. Mactear was attempting to solve, was whether this was an operation to which machinery could be successfully applied. They all wished to replace unskilled labour by machinery, but it did not always turn out that it could be done profitably, because there was always the element of repairs, and the necessity for greater skill in the working of the machinery. He was not going to suggest difficulties which Mr. Mactear might find in the course of working out his invention, for he had no doubt he was fully sensible of them himself, without any one disturbing him with additional ones. As he had already said, the experiment was of the greatest value and interest; and he knew that in another direction they were also having a similar experiment, because Mr. Allhusen was attempting a furnace on a very large scale, on Jones's new principle, to the results of which they would all look with great interest; and perhaps Mr. Allhusen would, at some future time, give them his experience in a paper. Mr. Mactear's process might be described as one in which the batches were of no size at all, because it was continuous; but Mr. Allhusen was going to try the same problem, where the batches were to be on a scale altogether unprecedented, so that they would be able to see which plan turned out the best. Meantime, the more cautious or timid manufacturers would go on in the old way, keeping, however, their minds perfectly open to receive light from any quarter. He was glad that Mr. Mactear, in his interesting retrospect, had given credit to Mr. Gamble, the grandfather of the gentleman now present, for that most important invention, the application of heavy cast-iron pans in which to decompose the salt. That had held its own, and would continue to do so until Mr. Alhusen or Mr. Mactear showed that something better could be attained. Mr. Mactear had spoken of the very severe labour of the decomposing-furnace men, but his impression was that these men made rather too much of it; they turned over a smaller quantity of material for a day's work than any other class of labourers who worked at furnaces, giving as an excuse the gases to which they were occasionally exposed. No doubt if Mr. Mactear succeeded in getting a gas-tight furnace, that would be an additional recommendation of his plan. He quite agreed with Mr. Mactear as to the conditions of successful working, but the degree to which they were complied with must be determined by experience. If rock salt could be used, that also would be very advantageous. He presumed it was the long-continued contact with the acid which made the decomposition of rock salt effective, which was not possible in the old way. There could be no doubt about the saving of labour. It went rather against the grain to see a man acting as a machine, working a heavy rabble, and they would all like to see men better employed—they would rather see them watching a machine than acting as one; but there came in the question he had before alluded to of the limit where you could replace brute force by machinery economically with more skilled labour to work it. He concluded by moving a vote of thanks to Mr. Mactear.

The vote of thanks having been passed,

Mr. Mactear, in responding, said there was one question he had forgotton to notice, viz., as to the condensing power. He could not give the exact number of cubic feet capacity, but they were doing two and a half times the work in the condensers which they could do in the same condensers connected to the old muffle furnace. After all, the chief point was that of repairs, and that could only be settled by experience. He had assumed the cost of repairs to be double that of the carbonating furnace, and after having done that, and having loaded the cost with 20 per cent. on the capital for depreciation and interest, there was still 2s. 6d. per ton to the good. Now, even if we were to assume there was another 1s. of that required for excessive repairs, and it would still leave the furnace economically successful. The Chairman said, "If he could produce a furnace which was gas-tight," but that he had already done, there was no question about it, and the same with regard to working rock salt, for he had shown them a sample of rock salt, abont 100 tons of which had been worked with perfectly good results. The delivery of salt cake direct into wagons for the balling furnace was of course a comparatively simple matter; and when laying down new works it would be comparatively easy to elevate the sulphate direct from this furnace into the hopper of the black ash furnace, weighing it on the way. It was in such a comparatively fine state of division that there was no difficulty in dealing with it.

FOREIGN AND COLONIAL SECTION.

Tuesday, February 1st, 1881; Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L., in the chair.

The paper read was—"The Industrial Resources of South Africa," by Sir Henry Bartle Frere, Bart., G.C.B., G.C.S.I., D.C.L., LL.D.

In order to obtain the final corrections of the author, the publication (at his request) has been delayed until next week, when a full report of the paper and discussion will be printed in the *Journal*.

The Chairman, in introducing the subject of the evening to the meeting, recalled to the memory of the members the circumstance that the African Section of the Society was opened, some years since, by Sir Bartle Frere, in an inaugural address, which is printed in the 22nd volume of the *Journal*. He was sure it would be a great delight to all members present on this occasion to welcome Sir Bartle back again amongst them, after the arduous task he had since then had to perform, and that it would also be a great satisfaction to the Society to receive the results of so large a practical experience in the affairs of South Africa, in the form of the paper, which would now be read.

Sir Bartle Frere then proceeded to give an account of the present state of the various districts of South Africa, comprising the old Cape Colony, including Kaffraria, Basutoland, and Griqualand West; the colony of Natal; the Orange River Free State; the Transvaal; and the Transgariep and Damaraland. He spoke of the mineral resources of each section of the land; of the agricultural industries; of the harbours, telegraph lines, railways, and of the recent rapid development of steam navigation; and he finished his address with a special allusion to the condition of the large population of native races that is still spread over the land, and to the necessity which this implied for good and strong Governments over them, if any effectual advance is to be made in the direction of a permanent civilisation for them.

After the reading of the paper, Viscount Sidmouth asked some questions regarding the harbours of South Africa. Mr. Jones exhibited some specimens of the diamonds of the Griqualand districts on behalf of Professor Tennant. Sir Bartle explained there could be no doubt Delagoa Bay was a magnificent harbour, and capable of being connected with the Transvaal by a short line of railway. Sir David Tennant, the Speaker of the Cape House

of Assembly, substantially confirmed the account given by Sir Bartle of the capabilities of the place, and described the extent of country which is already opened out by railways. Dr. Badger wished that it were possible some near neighbours of England, who were dissatisfied with their lot, could be got to understand that there was a good field for prudent industry in the land, described in the paper. Mr. Robert Rawlinson remarked upon the opening out of roads and the peculiarities of indigenous labour. The meeting terminated with a vote of thanks to the author of the paper, which was proposed by Sir David Tennant, and seconded by Mr. Pease.

NINTH ORDINARY MEETING.

Wednesday, February 2nd, 1881; ROBERT GIFFEN, Chief of the Statistical Department of the Board of Trade, in the chair.

The following candidates were proposed for election as members of the Society:—

Bridges, John, F.R.G.S., Marlborough-house, Sale, near Manchester.
Cochrane, Vice-Admiral the Hon. Arthur A., C.B., United Service Club, S.W.
Collingwood, Lieut. William, The Limes, Cheshunt, Herts, and India-office, S.W.
Fisher, John, 43, Mincing-lane, E.C.
Hall, William Shipley, 79, Cannon-street, E.C.
Haslam, Alfred Seale, Duffield-road, Derby.
Holder, Augustus, Corkicle, Whitehaven.

The following candidates were balloted for, and duly elected members of the Society:—

Barker, George E., Sutherland-villa, Chiswick.
Barlow, Walter Alfred, 6, St. Paul's-churchyard, E.C.
Buchan, William Paton, 21, Renfrew-street, Glasgow.
Burr, Frederick, F.R.G.S., Woodstock, Crescent-road, Crouch-end, N.
Temple, Sir Richard, Bart., G.C.S.I., C.I.E., D.C.L., The Nash, near Worcester.
Tovey, Major Hamilton, R.E., Waltham Abbey, Essex.

The paper read was on—

TRADE PROSPECTS.

By Stephen Bourne, F.S.S.

It has often been remarked that trade moves in cycles, depression and elevation alternating and succeeding each other at intervals, not indeed of exactly the same duration, but with such approach to regularity that at any particular period we may, with some pretension to accuracy, predict what is likely to follow within a short period of the time at which the observation is made. It is generally found, too, that activity is not confined to one or more countries; but, unless some special cause intervene, that prosperity or adversity pervades the whole trading world at very nearly the same time. The moving cause may originate in one place or in one branch, but it soon becomes more or less diffused; and this will necessarily become the more marked as rapidity of communication and facilities for transport are extended. The duration of these cycles is supposed to be about ten or eleven years, and, starting with 1837—the commencement of the present reign—in which, following upon severe banking and commercial embarrassments in the United States in the preceding year, there was a panic in London, we find that 1847, the year of the Irish famine, was also one in which, after the collapse of the railway mania of 1845, the commercial panic of 1846 attained its height. In 1857, again, the year succeeding the Russian War, and that in which the Indian Mutiny broke out, the Bank Act had to be suspended. In 1866, there was a panic amongst commercial and joint stock companies, the losses by which exercised a fatal influence upon the trade of the three following years; and since then, 1875-6, there was severe depression, from which the country did not commence to emerge until the autumn of 1879.

Between each of these dates there came a period of great commercial and manufacturing prosperity, producing an inflated condition, to be succeeded by the next wave of depression. It may be noted, however, that, as might naturally be expected, the interval between the height of one period and the depth of the other has generally been shorter than that of the following rebound. When once the tide begins to rise, it flows on with rapid progress, then descends rapidly, and leaves a long ebb, or at least a slight flow, until some event or condition of things sets the current of speculation moving, renders everything buoyant for a time, and then, having exhausted its force, a collapse ensues. The rise of the last decade commenced soon after the termination of the Franco-German War, in 1871, proceeded with unparalleled rapidity through 1872 to 1873, and had scarcely descended much in 1874; but 1875-6 were years of deep depression, those of 1877-8, with the first eight months of 1879, remaining at a very low level. The first indications of revival were observed in August, 1879; and though there have been ups and downs—rapid transitions since then—there has been a well-sustained general improvement through the year just ended, seeming to justify hopes of still further progress which may lead on to yet greater inflation than any we have before witnessed. The present condition of trade, and the forecast it offers, is the subject with which it is proposed to deal on this occasion.

England is so essentially a manufacturing and trading community that, notwithstanding there may be distress in other of her interests, when these are progressing well, the country may be said to be prosperous; at least, it wears the aspect of being so, notwithstanding that, as at this time, the agricultural interest may be suffering severely. The United States, on the contrary, is so markedly an agricultural nation that, even when the condition of her manufactures is not encouraging, she may, on the whole, be said to be flourishing. Therefore, without in the smallest degree underrating the importance of our agriculture, the place of first importance must be given to our trade, of which manufactures form an important branch. Herein lies a real difference between the United Kingdom and the United States, that the one has a large trade irrespective of her manufactures, whilst the trade of the other is principally in and with her own productions. British merchants, beyond

purchasing for our own need or selling our own surplus, deal with and in the produce of every part of the world, whilst at present—we do not say how long it may be so—American traders are chiefly employed with the interchange of goods which she produces for sale, or imports for consumption. Almost everything that is grown or made finds a market here, and, what is of immense importance, may be made the means of raising money, until the state of the market suits for or compels a sale. It is through this that we are so deeply concerned with the welfare of every land—share in their prosperity or are partners in their adversity.

Trade, in the widest acceptation of the term, has to be divided into two separate branches, the home and the foreign—which, though closely connected and greatly dependent upon each other—are often very differently circumstanced and exercise a greatly differing influence on the general welfare. The profits of the home trade depend upon its activity, and they do not add to the wealth of the country as a whole. That wealth, so far as it arises from home industry, is the surplus remaining of that which labour produces, after that which the support of the labourers consume is deducted. If, as on a former occasion* I attempted to prove, every worker does, on an average, produce twice as much as suffices for his own support and that of the non-workers dependent upon him; one-half of that which he produces may become the subject of trade, and, unless wasted or consumed, be so much additional wealth to some one. Its transfer from hand to hand by the traders through whom it passes, though profitable to one or more of these, does not make it the more valuable as a contribution to the wealth of the nation. Not so with our foreign trade. Whatever difference of value there may be between an article brought hither, and that with which it is paid for, is, if on the right side, so much added wealth; directly so, in if a permanent shape; indirectly so, if consumed in the sustenance of those whose labour produces something. But, once imported, no trading can give it additional value to the country; for, though one man may gain, it is at the expense of another. Home trade is the result of acquired wealth, and betokens, by its extent, the existence of prosperity. Foreign trade, always supposing it is not a losing one, is the creator of prosperity. For this reason, then, it is the prospects of foreign trade which demand the chief consideration. One more distinction it is necessary to draw, that between the trade itself and the traders by whom it is carried on. Ordinarily, if the trade be good, the trader profits by it, but not necessarily so. A merchant may purchase a bale of cotton goods with so much money, expend so much more upon conveying it to a foreign market, and there sell it at a loss. He may have directed the proceeds to be expended in purchasing so much wheat, which, when it reaches him, may sell for less than it has cost him, and so make a double loss; yet, after all, the wheat, when it arrives, may be of more value than the cotton originally sent away. The country has been a gainer, though the trader has been a loser. It is the gain or loss which accrues to the country from this trade which it is proposed to consider, not that which pertains to the individual trader.

Again, our foreign trade must be divided into export and import. There is no need here to raise the much vexed question as to which of these it is that best evidences the prosperity of the country. That has been fully examined in a paper on the "True Relation in which Imports should stand to Exports;"* but, in the belief that, in the present condition of the country, it is the exports on which our trading prosperity depends, they will, in the first place, occupy attention. This opinion receives striking confirmation from the following figures, commencing with 1872, admittedly the year in which the inflation of trade reached its greatest expansion, when, also, our exports of British produce and manufactures attained a higher value than any previous or succeeding year has seen, whilst our imports have not progressed in the same sequence. The goods exported, after having been previously imported from abroad, are excluded from both sides of the account† :—

	Exports.	Imports.	Excess of Imports.
	In Million £'s to Two Decimals.		
1872	256·26	296·36	40·10
1873	255·17	315·45	60·28
1874	239·56	311·99	72·43
1875	223·47	315·79	92·32
1876	200·64	319·01	118·37
1877	198·89	340·97	142·08
1878	192·85	316·14	123·29
1879	191·53	305·74	114·21
1880	222·81	350·00 (?)	127·19 (?)

As trading prosperity waned so did the amount of our exports fall off, as it waxed so have they begun to increase. They have not yet reached the level of 1872, but a growth similar to that which has taken place in the last year, would bring the present one up to almost the exact amount of 1872, the decade thus ending as it began.

A somewhat closer examination of these figures is necessary for an estimate of their true import. It would be tedious to go through all the various articles of export, and this having been done elsewhere, the result has been to show that, taking the three great industries of cotton, wool, and iron, the teaching they afford does not differ from that of the whole. It will be sufficient to take the three years—highest, lowest, and last—thus :—

Exported.	1872.	1879.	1880.
	£	£	£
Cotton manufactures	80·13	63·97	75·56
Iron, including hardware and machinery	49·35	29·73	41·08
Woollen manufactures	38·49	19·57	20·60
	167·97	113·27	137·24
Per-centage of whole exports.................	65	59	62

With these amounts, it may be useful to compare

* "Trade, Population, and Food." London, 1880. Pp. 114, *et seq.*

* Same volume, pp. 162-192.

† The tables throughout are constructed in millions to two decimals: thus, for 256·26, read 256·260·000.

the quantities, so far as they are shown in bulk in the published returns, viz :—

Exported.	1872.	1879.	1880.
Cotton piece-goods (yards)	3,535·16	3,724·65	4,496·34
Iron and Steel (tons) ...	3·39	2·88	3·79
Woollen piece-goods (yards)	384·82	232·90	240 0)

This comparison brings out the fact that, whilst the quantity of cotton piece-goods is larger in 1880 than in 1872, by 25 per cent., the money value is actually smaller. For the same years, the price of the raw cotton imported having been in 1872, 68s. 5d.; 1879, 55s. 1d.; 1880, 55s. per cwt.

The tons of iron exported were 10½ per cent. more in 1880, the money value 21 per cent. less, the price of pigs being, in 1872, 102s. 2d.; 1879, 45s. 2d.; 1880, 63s. 10d. per ton.

The quantities of woollen piece-goods had fallen 42 per cent., the money value 46 per cent., whilst the price of the wool imported was—1872, 1s. 2·3d.; 1879, 1s. 2·5d.; 1880, 1s. 1·6d., per lb.

The inference to be drawn from these variations is, that in each class of goods the profits realised by the sale must have been much smaller in the last year than they were in the first of the three periods.

A glance at the values of our imports given above, will show that their amount, in the several years, does not vary with the degree of trading prosperity. In this they differ from the exports, and for more than one reason. For our exports we get the best price we can, and if the markets to which they are sent rule low, we must be content with small profits or none at all; whereas, with the imports, we must buy largely for our own sustenance, and if the prices are high we are compelled to pay them. The supplies of food we need depend much upon seasons of fertility or otherwise at home, but are steadily increasing with the growth of our home population; the whole of which increase must necessarily be thrown upon foreign sources, since we grow less by more than one-half than suffices to feed the existing numbers. Three classes of articles may be selected to illustrate the relation which these bore to the whole, in the same three years as were taken for the exports, thus :—

Imported.	1872.	1879.	1880.
	£	£	£
Articles for consumption as food and beverage......	148·25	173·97	187·20
Materials for textile manu-manufacture	92·40	73·11	84·23
Other manufactures, &c...	50·79	46·81	61·82
	291·44	293·89	333·25

These figures disclose the fact that, whilst our food imports, as between the period of the highest prosperity and revival, 1872 and 1880, have increased 26 per cent., and other articles 22 per cent., there has been a decline of 9 per cent. in the value of the supplies taken for the support of our textile manufactures. But if the comparison be made between last year and its predecessor, it will be found that all have increased in the proportion of 8, 32, and 15 per cent. respectively.

A point of considerable importance, as regards the indications these figures afford of growing prosperity, is to ascertain whether these increases owe their existence to the sale or purchase of larger quantities or at higher prices. A series of very elaborate calculations into the values of 1879 and 1880 give these results as to the exports, that the gains in the value is due on :—

	Cotton.	Per cent.	Wool.	Per cent.	Iron.	Per cent.
	£		£		£	
To volume of exports	9·01	83	·69	70	6·16	70
To price at which sold	1·87	17	·30	30	2·70	30
	10·88		·99		88·6	

From this it would appear that the additional profit obtained by our cotton manufactures (of 17 per cent.) has been, proportionately, far less than in our iron or wool, in which the relation of volume to value is exactly the same—30 per cent. So with our imports, the additional values in the one year over the other have arisen, in—

	Food.	Per cent.	Textile Materials.	Per cent.	Other.	Per cent.
	£		£		£	
From volume of imports	5·23	40	7·22	65	10·50	70
From price of imports	8·00	60	3·90	35	4·51	30
	13·23		11·12		15 01	

Showing that, to the higher cost of our food we owe 60 per cent. of the increased payment, and to the other classes only 35·30 per cent. This is important, seeing that the one is consumed, the others are, to a considerable extent, recovered in the prices obtained on the sale of the manufactured goods.

Putting together the whole of the articles which have been included in these calculations—being all the principal ones that, from the nature of the information supplied, admit of such investigation—it will be seen that of exports, to the value of £203·12, in 1880, the excess over 1879 was £26·26, of which £18·68 was due to greater quantities, and £7·58 to higher prices. Of imports of foreign goods, to the value of £333·25, the excess was £39·36, of which £22·95 arose from greater bulk, and £16·41 was due to greater cost. That is, that for the extra receipts for exports we had to give 71 per cent. more in quantity, whilst out of our extra payments for imports, only 58 per cent. went for additional bulk.

From what has now been said, it is evident that

there has been, during the past year, a real and substantial revival in the export trade of the country, accompanied by a still greater expansion of its imports. The real start in both, from the lowest point of 1879, is really greater than has been shown; for the turning point having been in August of that year, the gains in the latter months, hide some of the losses in the former ones, as may be shown by altering the period of the year to which the twelve months are compiled, thus—

	Total Exports.		Imports.
12 months, ending 31st July..	£214·24	..	£404·31
,, ,, 31st Dec...	222·81	..	409·99

Before proceeding in an attempt to forecast the future progress of our foreign trade, from the evidence afforded by the past, and especially the recent past, it may be well to inquire somewhat into the condition of the home trade; premising that the facts being much more difficult to ascertain, the results they give are inferential rather than positive.

Of the extent to which cotton has been manufactured for home use in the three several years, it is possible to form a tolerably correct judgment. By deducting from the weight imported the quantities exported in the raw condition, and then calculating at the generally accepted rate, of five yards to the lb., we can guess at the quantity that has, during the year, been absorbed in the manufacture of goods for domestic consumption. Thus—

	1872.	1879.	1880.
	cwts.	cwts.	cwts.
Raw cotton imported	12·64	13·17	14·55
Raw cotton exported	2·43	1·68	2·01
Retained in this country..	10·21	11·49	12·54
Cotton piece goods exported	6·30	6·60	8·00
Yarn and thread	2·—	2·20	2·—
	8·30	8·80	10·00
Leaving for home use	1·91	2·69	2·54

There is thus reason to think that the home demand cannot have been greater during the past year than in the previous one, though both considerably exceeded that of 1872.

As regards the progress of woollen manufactures, we are not able to calculate so closely, but some information is afforded by the quantities of the raw material imported and exported.

	1872.	1879.	1880.
	lbs.	lbs.	lbs.
Wool imported	380·80	500·20	568·37
Do. and yarn exported....	184·91	292·40	281·02
Retained for use	195·89	207·80	287·35

It is not possible to estimate the weight of wool employed in the manufacture of the goods exported, but as these, in 1880, have not, in the gross, exceeded those of 1879, by so large a proportion as the raw material retained for use in the latter years has done; there is room for supposing that there has been a greater consumption at home, although the trading reports scarcely bear out this supposition.

Coming next to the iron industry, the raw material for which is principally of home production; we find that the impetus given to manufacture for export, has induced a more than corresponding increase in the number of furnaces put into blast, and hence the manufacture of a larger output. It has been estimated that the quantities may stand thus:—

	1872.	1879.	1880.
	tons.	tons.	tons.
Pig iron produced..............	6·74	5·99	7·20
Importation of iron ore	·80	1·08	2·63
Exportation of manufactured iron	3·39	2·88	3·79

It is generally admitted that the stocks in hand are larger than they were last year; and, if so, it is difficult to see how there can be such a greatly increased demand for home consumption as is supposed. There can, however, be no doubt that the additional number of ships known to be on the stocks, or recently off them, must have required more iron for their construction. It is significant, too, that the exportation of iron in December last was some 22,000 tons less than in the same month of 1879, and that the stocks in bond in the United States, which has been our best customer of late, are greater than they were.

Another feature, which is generally and rightly taken to indicate the briskness of trade, is the amount of railway traffic receipts, which, as published, have during the past half-year amounted to £226·27, being an increase of £1·01 on the corresponding period of 1879. This, however, must not be attributed wholly to the home trade, for the carriage of goods, especially iron to the ports of export, and the transport of grain from the ports of import, will have added largely to this extension of traffic.

The London Clearing-house returns again are evidence that something which is worth money is passing from hand to hand. Yet this may not be so much from trade in goods as from speculation in funds, stocks, and shares, as may be inferred from the very large figures of settling days—1879, £4,859· millions; 1880, £5,716· millions.

Any review of our trading position, or attempt to estimate its progress during this or following years, must be incomplete if attention be not paid to the state of our finances. The low rate of interest at which money is to be lent, and the high price at which Consols or other stocks are to be sold, may evidence either that trade is so profitable as to provide large surpluses for investment, or so contracted as to leave little room for the employment of capital already acquired. As a rule, however, when trade is brisk, money is dear, and cheap in times of limited employment. This has been and is the case in the last and the present years, and the gradual hardening of the market induces the belief that money is now finding employment in trade rather than in fixed investments. Yet, it will not be safe to rely too much

upon this as evidence, for, with increasing facilities for interchange of money securities and credits, the plethora or scarcity of available money in this country may be affected by circumstances other than those of trade, at home as well as abroad. An attentive survey of the state of the money market, as evidenced in the Bank rates, the stocks of bullion held by the Bank, the prices of the public funds and other securities yielding a fixed income, at the different periods of our commercial history, cannot fail to throw much light upon our trading condition at the present moment, and its probable progress in this and following years. But this subject is so much complicated by the operation of political movements in other countries as well as our own, and influenced by a variety of other causes, into which there is not time now to enter, that it must be passed somewhat lightly over.

The mere fact that money is plentiful or otherwise in New York, Vienna, or Paris instantly acts upon the available supply in London. Nor is it possible at all to ascertain where the money employed in any one trading or mercantile centre is really owned. Thus, English mercantile bills are constantly discounted in Paris and *vice versa*, just as the current rates of interest in the one place or other may make the process easy to be effected; and purchases of English funds or stocks may be made on American account without any movement of either bullion or goods. There is reason to believe that, during late years, when the balance of trade between England and the United States was increasingly against us, American securities held in England were largely bought back in payment for our excess of imports; and, though now it is stated that very large purchases of American railway and other stocks have been made here by *bonâ fide* investors, it is difficult to see how the purchase-money has been transmitted to the other side of the Atlantic; seeing that a comparatively small amount of bullion has been sent over, whilst our obligations for imported food have been very large. Judging by present appearances, it would seem that there is no lack of money for trading purposes, or for increasing means of manufacturing articles for export, but very little disposition to put it fully to such uses; thus evidencing very little confidence in any great expansion of trade being about to arise.

Too much stress has been laid upon the great rise in the prices of all public securities, which is variously stated to have been 15 and 17 per cent. within the year, equaling upon three to four thousand million pounds sterling—the estimated amount held in the United Kingdom—an addition to capital of 450 to 600 millions, and this is spoken of as though it rendered the country actually more wealthy. No one really believes that the country's wealth has thus increased. An individual holder, or even a number of such, seeking to realise investments, may now do so to an advantage; but let the whole, or even a large number of such holders seek to turn their stocks into money, and prices would immediately recede. Yet this nominal growth of wealth is, to a great extent real for trade purposes. Bankers and others will lend on such securities more when they are high than low, or, at any rate, their owner can obtain more credit with which to traffic. It is this credit that creates so many fluctuations in trade. A belief arises that more goods will be required for exportation or consumption, and forthwith purchases are made, in the expectation of selling again. Prices go up, as willing buyers increase, until it is found that the real demand is small, and forthwith there is a rebound. This has been evidenced in the transactions of 1879-80. Orders came from America for iron, principally in the form of rails, or pigs to make rails; production was increased; prices went up, then fell, and now have partially risen—to fall, it is probable, still more when it is found that the demand has slackened or ceased. This demand really arose from two causes: the excessively low figure to which our prices had fallen, and the lamentable deficiency in our late harvests, which rendered large purchases of grain necessary. The ready sale which American agriculturists found for their produce induced the belief that extended cultivation would be profitable. To do this, additional railways were necessary, and, our rails being cheap, they, instead of money, were taken in payment. This saved us from the expected drain of bullion for the time, and, should our harvest this year prove good, may save us from it altogether. If so, the anticipated expansion of trade with the United States will not go on for any length of time. Other causes have acted in a similar manner upon other branches of trade, as evidenced in the following figures, showing the destinations of our additional exports during the twelve months ending 30th September last, as compared with the trade to the same countries in 1872 and 1879.

Value of Exports.	1871-2.	1878-9.	1879-80.
	£	£	£
To United States	40·53	16·30	31·99
,, British India	22·37	23·64	31·15
,, China and Japan	11·34	9·28	12·33
,, all other countries	173·02	138·32	142·91
Total	247·26	188·04	218·38

Thus the increase in our exports in the one year was:—

	£			
To United States ..	15·19	=	90	per cent.
,, British India ..	7·51	=	32	,,
,, China, Japan ..	3·05	=	33	,,
,, Other countries	4·59	=	3	,,

The similar figures for the year ending December last, are not yet published. The total, however, for the year, as found in the monthly return, is £222·81, or £4·43 above that for the twelvemonths ending in September, that being the excess of the last quarter of 1880 over that of 1879. The larger portion of this excess will, probably, be found to be to India; and some to Australia and Canada, with whom our trade has been little of late. Yet, even when this is added, it will still be seen how limited has been the area of enlarged export. The "other countries"—that is, all the world besides, America, India, China, and Japan—taking from us 143 millions out of 218, have not, at furthest, increased their purchases by more than 5 or 6 per cent. Nor does this represent greater

trade, since the general rise in prices will account for some 4 per cent. of the additional value, leaving the quantities of the goods much as they were before. With one-third of our customers we have done better business in 1880; with two-thirds it has remained stationary, even during the recent expansion; whilst, as compared with 1872, it has been worse, by from 20 to 25 per cent.

These are serious considerations as regards the anticipations which are to be formed for the future, and should enforce the utmost caution in all trading and manufacturing engagements. Yet it is to the newer countries, those which have not yet become peopled, or, if peopled, where arts, manufactures, and commerce have yet to be introduced or developed, that we must look for any permanent or profitable increase of trade. It is to these we should send our capital and labour, if we would create new markets or raise up new customers.

History, it is said, repeats itself, and if trade prosperity is to proceed as in former times, the cycle must be near its end, and the advent of its highest tide be at hand. It is necessary, therefore, to study the course of the past fall and rise, that we may know how and when we may expect its completion. Such also would seem to be the general expectation of all who are engaged in trade. Most of the circulars issued at the commencement of the year speak of the past 12 to 16 months as those in which there has been much fluctuation, but withal a growing improvement which promises to become fully developed in the months or years soon to follow. The late depression has been longer than its predecessors, and from this it is inferred that the revival will be more rapid. But such repetition seldom or never is complete in all its features, and it may be well to look also at the points in which the present condition contrasts with that of the years during which the last flood was running.

In 1870, the exports of British produce and manufacture rose but ten millions; in 1880, they increased more than thirty; whilst the imports retained for home use, in 1870, were only swelled by the same ten millions, whereas in 1880 the addition has been to the extent of forty-five millions of money. The total imports retained may be thus divided:—

	1870.	1880.
Food	100	185 (?)
Raw material	119	120 (?)
Manufactured	40	45 (?)
	259	350 (?)

In 1870, our imports exceeded our exports by £59 millions, in 1880 by 127. In 1870, we had had in succession three of the best harvests ever known; in 1880, with one exception, six of the worst. In 1870, the population which produced our 200 millions of exports, and consumed the 100 millions foreign supplies of food, was 31 millions; in 1880 it will probably have numbered 35 who were only able to export 222 millions, whilst consuming 185. In all these respects the condition of the country was widely different from that of the present time, and it seems impossible that trade should run the same course.

Again, 1870-1 was the year of the Franco-German War, which—whilst it rendered both countries in large measure dependent on this to supply their wants—paralysed their own trade, and lessened their powers of production. Now, ten years of peace has enabled both of them greatly to increase their trade, and that in many articles which rival ours. America was scarcely beginning to recruit the resources wasted in her civil war. Now she is entering upon a competition and race with Great Britain, the keenness and fierceness of of which promises to exceed the wildest expectations which could have been entertained ten, or even five, years ago. The power of supplying the wants of the world has increased in greater degree than those wants have grown, or rather than the means of paying for their supply have expanded; and we have not preserved our relative superiority in producing power.

To take another view of the case; in 1870, we were at peace with all the world; we have now to meet the cost and overcome the disorganisation resulting from contests in India and the Cape; from the decay of the Turkish Empire, the trade with which was, to us, formerly, a source of the greatest profit; and, however soon the condition of Ireland may change, there can be no doubt that its present state is entailing losses which must have an effect upon our commercial progress.

All these considerations should check any exuberant hopes that the inflation of 1872-3 is about to be revived. The progress already made during the past year has been very spasmodic. Of this no surer token can be adduced than the fluctuations in the price of iron, the article of our trade with which the revival commenced, and on the continued demand for which much extravagant expectation has been based. It is but too evident that speculative action drove the prices of this and other things far higher than the extent of the trade in them warranted; and though at present prices may be at a fair level, they are not so high as to yield great profits. Any permanent increase in cost or selling price would, in all probability, put a check to demands which, there is reason to believe, grew out of exceptional circumstances not likely to exist for any length of time.

It is the undue influence of this speculative element which threatens to revive the fatal inflation of 1872-73, for though during that period there was much real accession of wealth to the country as well as to individuals, there was still more that was false. Since then, and as the result in great measure of the course then pursued, there have been sad and heavy losses; not solely to the wild speculators the cessation of whose butterfly term of prosperity there is no reason to deplore. In such seasons the hard-earned savings of the prudent and careful, the provision made for widows and orphans, become placed in the hands of financiers, who unduly stimulate trade, only to prepare the way for renewed depression, and for all the misery which such catastrophes as the Glasgow and West of England Bank failures inflict upon the undeserving sufferers. Yet, altogether undeserving many of those who suffer can scarcely be said to be. It is the speculative spirit which seems to possess so many of all classes, that opens the door for those who thrive by its existence and cultivation. Since 1872, the number of these, and the boldness of their flights, have vastly increased, and it is painful to see how constantly the writers on trade subjects speak of speculation, as though it

were the legitimate basis upon which the expansion of trade is entitled to rest. To judge by present indications, if trade does so rapidly revive, it will have very little firm ground upon which to stand. There is really nothing more solid to justify the extravagant anticipations so generally formed—nothing more likely than this speculation to wreck the prospects which may be safely entertained, that a gradual, though slow, improvement may be maintained.

What, for instance, are the prospects that our trade with America will, next year, exceed that of the last? She found us in want of increased supplies of food, owing to our bad harvests; and from her extended agriculture supplied our wants. She found, too, that our iron trade was suffering great depression, that prices were so low as to permit importation into her country profitable, even under prohibitory duties (levied as such, more than for revenue purposes). We purchased her corn at good prices, and paid for it with iron, sold at the outset at poor prices. Believing that this state of things permitted of continuance, and flush of means from her profitable exports, she determined to lay down rails, to enable cultivation to be extended further inland; thus taking off our hands accumulated stocks, and even new supplies, at prices which became, as they went higher, the stimulus to further production. Unless, however, in the meantime, new openings for trade can be found, it is not at all probable that this will continue. A good harvest at home, should we have one this year, will leave much of the grain now growing for our market as surplus stock in the hands of the Western growers, and thus prevent the continuance of the purchases from our manufacturers which has had so much to do with sending prices up. Should this be the case, it may, in the end, not be disadvantageous to us, for so soon as agricultural production in that country exceeds the demand, or from other causes prices fall so as to be less profitable, the growers there will become unwilling to protect, their various manufacturing interests, at an excessive cost to themselves, and thus bring about the reduction or abandonment of prohibitive or excessive duties. This is the direction in which we may look for the growth in America of free-trade principles, the establishment of which must, sooner or later, be consummated. This may, for a time, be allowing our manufactures to come into competition with her own; but the progress she is making in the neutral markets of the world forbid the hope that she will long allow us to hold our ground where our products have hitherto predominated, still less increase her internal consumption of those imports which she has in herself the power of producing. The figures already quoted show that our exports thither are not on the increase, and when the next quarterly return of values appears, it will probably show that the trade with her in our own manufactures has already begun to decline.

If we turn to India, the country which, next to the United States, has contributed most to the revival of our export trade, the prospect is more hopeful. Yet, even there, the recent exports must be deemed exceptional. During the famine, her power of purchasing was limited; much that has been sent there during the past year has been to supply previous deficiences, and it is understood that stocks of cottons are accumulating. Two-thirds of our exports thither consist of cotton manufactures, and though it may not be for some time to come, it is not probable that India, with the raw material on the spot, and with labour so much cheaper than here, will, any more than America, fail to manufacture for herself. There is greater likelihood of her requiring larger supplies of iron to extend her railway system, though this must come slowly; but the capitalist who would now erect cotton mills with the intention of manufacturing more largely for Indian customers, must be guided more by faith than reason.

The third principal quarter from whence large orders for our manufactures have come is China and Japan. Here, again, far more than the half of the goods these countries take from us are cotton in pieces and yarns—a trade which is likely to continue, and may greatly increase. At present there seems little opening for selling them iron in any quantity, but so intelligent a people are sure, before long, to see the advantages of railway communication; and unless we are beaten out of the market by our neighbours in Belgium and Germany, there is every reason to anticipate that these people may prove extensive customers. There is no absurdity, however, in the belief that when that day comes it will be accompanied, or preceded, by such an eruption of the Chinese labourers as may seriously compete with our own workers, in our own places of production.

It is exceedingly unsatisfactory to find that the Australian colonies have contributed little to the recent growth of our exports. Canada has done much better in 1880; but then 1879 was one in which she fell off in her demands for our goods. There seems but little reason for hoping that any great extension of trade to these colonies will speedily take place. The South African trade must receive a severe check—excepting for the necessaries expended in war—from what has, and is, taking place there.

So far, then, as the present outlets for the products of our mining and manufacturing industries are concerned, there would appear to be very little solid basis on which to hope for any great extension of our trade in the present or coming years. It may even be that the revival has reached its height, unless wild speculation attempts to force our goods on markets in advance of their requirements.

It will be gathered from what has been now said, in connection with his previous expressions of opinion, accompanied by copious compilations of figures, that the writer sees but little to desire in the rapid extension of the import trade; and that he sees nothing to regret in the fact which last month's official returns manifest, that this expansion has received a check. The figures of the coming year will possibly prove this to have been something more than accidental or temporary. Without again going over the ground so well trodden on former occasions, it may now suffice to say that he sees no reason to doubt the soundness of two arguments, which he thinks the history of the past decade should remove from the region of controversy—namely, that a continued growth of imports, unaccompanied by a corresponding increase in the exports, cannot be an evidence of increasing wealth; and that it is by no means satisfactory to find that the whole value of our exports, deducting the cost of foreign materials which enter

into their manufacture, now falls far short of the price we have to pay for the food which our increasing population requires for its support. Further, that so long as our increasing population fails to spread itself over the unoccupied and uncivilised lands which lie ready for cultivation; and continues its present wasteful expenditure of substance, labour, and life, the prosperity of the country requires the expansion of its export trade far beyond the present bounds, or those that seem to be within reach. With one other remark, he would bring this already too extended paper to a close. It is this, that for such expansion the fullest freedom of trade is absolutely essential, and hence, that any attempt to fetter it with the shackles of reciprocity, or to crush it under the dead weight of protection, would be fatal to the continuance of that trade on which, under present conditions, our existence as a nation depends.

DISCUSSION.

Mr. Samuel Hill said he should have liked to have heard Mr. Bourne's criterion of value. His experience taught him that the prices put down at the Custom-house were nothing like the cost, or mercantile price. He would also point out that the import values were inclusive of freight, while the exports were not. He remembered the first shipments of rails to the American markets, when the prices realised, including an *ad valorem* duty, were no test of the price obtained by the English merchant. He did not agree that the large exports of rails to America had been principally paid for in cereals, for, in many instances, he believed they were paid for in American railroad and other securities. These were points to be borne in mind in determining our future trade with America. The late activity in this line was attributable to the facts that the price was very low, and that iron-masters were so desirous of increasing their trade, that they took securities, which, in cooler moments, they would not look at. A very important question, which had not been dealt with, was that of labour. There were two giant forces, capital and labour, and if they opposed each other the danger was as great as the collision between two steamships or two express trains; yet sufficient attention was not paid to keeping up good relations between these two forces, nor was the dignity inherent in labour sufficiently recognised.

Mr. Cornelius Walford was glad to find Mr. Bourne, in some degree, more hopeful than he had been in the past. He had been accustomed to think that if trade should never again revive, but become worse, Mr. Bourne would have been one of the greatest men alive, because he had always predicted it, but now he feared his fate would be more like that of Goodwin the astrologer, who predicted the burning of London, but he was so much ridiculed for having done so, that he denied having made the prophecy only a few weeks before the great fire occurred. He (Mr. Walford) thought there were decided indications of improvement in trade; but he was not at all sure that the cycle or sun-spot theory had not misled a great many people. It was quite true that, looking at the history of commerce for the last century and a-half, there were recurring periods of expansion and depression, and the latter had always been accompanied by predictions such as were now made. About 1819, the agricultural interest was believed to be as much depressed as it was now, and it was said it would never recover, but while it did recover, he was disposed to think that it was in a worse state now than it was then. There was no doubt that America was the great rival of Europe with regard to agricultural produce, and it must be so. It would be a bad day for America, if our harvests were more productive. But apart from details, the general question was this—was it possible, with the vast ramifications of trade, to bring together in one focus all the circumstances which went to make up the greatness of a nation? He thought not. With all the skill and knowledge that even Mr. Bourne could bring to bear on the question, he did not think it was possible to truly forecast the future. And it was well it was so, or speculation would be more rife even than it was at the present. When he saw these great periods of expansion, when the exports approached or exceeded the imports, he did not consider they were the periods of greatest prosperity, but rather the immediate precursors of panics, when the fruit of the speculation of the past was becoming ripe. He hoped, therefore, that, taking a lesson by the past, whatever trade was doing now would be done with safety, and then, if individual or even national profits were smaller, the progress made would be more secure. They would then have an honourable trade, and one which was good for all concerned in it. The thing required, in his mind, was steady progress, and he was quite sure that the discussion of these questions by Mr. Bourne, the Chairman, and others had done good. The problem had been considered all over the world, and though some of the colonies were taking a course with regard to protection which they at home might think wrong, still there were two sides to every question, and the colonies which exported so much raw produce might be justified in taking a course which, to us in England, who imported so much, might seem wrong. No man could safely predict the future in these matters, for he must bow to the force of events.

Mr. Christian Mast thought there was a contradiction in the paper between theory and practice. The practice, as carried out in the figures, was excellent, but the theory at the beginning seemed to be that of cycles, which was not trustworthy. All the circumstances of trade must have causes, and in his opinion the causes were terrestrial only, and had nothing to do with the sun. If Europe was prosperous, it must result either from good harvests, or from the state of affairs and society. He thought periods of prosperity could always be traced to public tranquility, and bad periods to a disturbed state, social or political. Nothing appeared to him plainer than that in 1871 England was prosperous because France and Germany were depressed, and so in other periods.

Capt. Bedford Pim, R.N., said he must join issue with Mr. Bourne as to the last part of his paper, wherein he deprecated reciprocity and protection. If any one looked around, at the results of free trade, he must feel unbounded astonishment that any one had been wild enough to follow such a Will-o'-the-Wisp. There was not a nation on the face of the earth which had followed Great Britain in this respect, and they could hardly suppose they were the only people in the world who knew what was beneficial. Take the United States. In 1869, they owed £551,000,000; but, in ten years, they had paid off no less than 128 millions sterling, and were now progressing by leaps and bounds, whilst England had only paid off 10 millions of debt since the Queen's Accession. Free trade was to have given cheap food, but Mr. Bourne had admitted that provisions were dearer all round than they used to be. He would at once put a duty of 5s. a quarter on corn, which would produce five millions of revenue, and would only increase the price of bread 3d. on 14 quarterns, while it would enable the English farmer to live. Mr. Read told him that it was impossible to grow corn in England under 40s. a quarter, whilst the Americans could lay it down here at 38s.; so that a 5s. duty would equalise matters. Again, in his own profession, it was most important that we should have grain brought in our own ships, but, owing to the repeal of the navigation laws, 80 per cent. of our seamen were foreigners. He was not going to run down foreigners, and the Russian Finns made splendid sailors, but suppose there were a war with Russia,

they would not bring grain cargoes to England. Corn would, in such a case, no doubt, be made contraband of war. A Bill had just been declared urgent in the French Senate for giving bounties to French shipping, and no doubt it would very soon become law. What was England going to do then? Her sugar industry had already been ruined, and 20,000 men thrown out of work by the French bounty system. Steam and telegraphs came into being soon after the free trade system, and soon after came the gold discoveries in Australia and California, and these things caused an expansion of trade, but that was a very different thing from extension. In conclusion, he expressed his opinion that there was never a more complete piece of humbug than free trade.

Mr. B. Francis Cobb said there could be no doubt of the value of the paper, whatever criticisms might be made upon it. He himself should be inclined to criticise some portions of it, as, for instance, where the author said that when a thing was once imported into this country it did not alter its value the more it was manipulated; but if that manipulation consisted of labour expended upon it, and was then re-exported, there was certainly a gain to that country. There was no doubt a great deal to be said on the question of freight, as bearing on the value of exports and imports. The value of money as an importing power was less than it was, and the same quantity of money did more work now than formerly, owing to telegraphic communications. If he wanted to import seeds from India, he had only to give security to an English bank, and he could telegraph out a credit to his agent in India, who could purchase what he required at once, so that an immense amount of the capital which was formerly required to carry out such operations was saved. By this means a much smaller per-centage of profit would repay the merchant, because much less capital was required than in days gone by. All this made it more difficult to forecast the state of trade for the future. When a want arose it was immediately supplied, and there was not the same opportunity for speculation. With regard to Captain Pim's remarks about the colonies and free trade, he would recommend him to compare New South Wales and Victoria. The former, which was a free trade colony, was fast outstripping Melbourne, which was saddled with high protective duties. With regard to foreign sailors, though he had not the statistics at hand, he was convinced there were as many Englishmen under the British flag as there were 30 or 40 years ago; there were certainly as many British subjects.

Mr. Liggins said Mr. Bourne deserved their thanks for the able and exhaustive paper he had prepared, but he was surprised at the conclusion arrived at, to which Captain Pim had already referred. The author had given figures which he considered most disastrous for the future of English trade, and he had stated most truly that the growth of imports, unaccompanied by a correspondent increase of export, could not be considered as evidence of increasing wealth. He (Mr. Liggins) read in the *Times* that morning that one of the largest steamers belonging to the Steam Navigation Company, the *Libra*, had been in collision in the river, and she was going to Hamburg in ballast to fetch a full cargo of manufactured goods for this country, and he did not see how that could be a transaction for the benefit of England. He had always understood that they lived by what they sold, not by what they bought. He was a West Indian proprietor, ruined by free trade, which he could not too strongly denounce. Another thing he saw in the *Times*, was the loss of an English ship, bound from Demerara to New York, with a cargo consisting of the produce of English colonies, intending to return from the United States with a cargo of manufactured goods. How could that be to the advantage of England? He had in his hand a West Indian newspaper, in which three out of four of the advertisements were from New York traders. One third of the crop of Antigua went last year to New York. All those islands were sending their sugar to America to be manufactured, and that only came to England which was mortgaged to English merchants. He was a shipowner, and the greater part of the sailors he had to employ were foreigners, and he feared that, in case of a war, we should find a difficulty in getting men to man our ships and fight our battles. Mr. Bourne's figures were black enough, but he did not think they were as black as the reality. He could corroborate what Captain Pim had said about French shipping, for only lately a French nobleman had told him that France intended to do all the trade of the world, and to drive England out of the market. But there was a worse feature even than that, for there was a strong agitation going on in America to subsidise American ships, in order to drive the large English steamers off the line. He held shares in one of the largest steamship companies, which last year paid no dividend, and he knew of one Liverpool vessel which lost £4,000 by one voyage. This could not go on. If England lost her ships, her colonies, and her commerce, the figures would soon be much worse than any Mr. Bourne had given. He did not think it was fair to compare 1879 and 1880, because accidental circumstances might show an improvement in one year; the comparison ought to be made with 1872. With regard to the sugar industry, he considered it a great mistake to take the duty off sugar. It produced five millions of revenue, and gave the working man an opportunity of contributing something to the revenues of a nation which gave him such high wages. Working men were beginning to see that a free breakfast table was a mistake, and meant low wages. The working classes should rather make the things they manufactured higher in price, and then they would get good wages; nine-tenths of them were now beginning to see that free trade brought them low wages. In the Kensington Town-hall £10,000 worth of Belgian iron was employed, and in the Albert-hall, £70,000 worth, and that was certainly no benefit to the working classes. The figures showed they were importing more than they were exporting, which must mean ruin in the end.

Mr. Pfoundes said, when he was in Japan and China, he had many opportunities of mixing with the natives, and looking at trade questions from the native point of view, and the result of his experience was that one of the most crying needs for successful English commerce was more competent agents. For want of these, most important work was committed to natives, who, of course, used the information they obtained for their own benefit. Again, the old-fashioned system of English trade there was on far too expensive a scale—a greater part of the time of the agents being spent at the club, tiffin, or full-dress dinners—the consequence being that our trade charges were out of all proportion to those incurred by the more thrifty of our continental competitors. Again, in the consular service, young men, admirably trained in many respects, were sent out, but they were not allowed to engage in trade; they knew nothing of trade matters, and could not compete with the representatives of other countries. He could not agree with the criticism of a previous speaker, that Mr. Bourne's figures were not trustworthy.

Mr. Hill asked if Mr. Bourne could give an idea of the present purchasing power of money, as compared with 1826 or 1828.

The Chairman said that though the discussion had been interesting, it had to a certain extent been discursive, one or two sentences in the paper having led into a discussion of the principles of free trade. He should not go into that question at any length, because, notwithstanding what had been said, he should assume that the majority of those present, and at any rate the Society, as a whole, were sound freetraders. He must remark, however, that notwith-

standing all the predictions which had been made as to the evils which would follow our free trade system, the ruin had been very long in coming, and he was prepared to maintain that, at the present time, there was no country in the world, not even excepting the United States, more prosperous than Great Britain, or where such a large mass of people had employment at good wages, and had so fair an opportunity of enjoying life in health and comfort. With regard to foreign countries imitating our free trade policy, he might remark that if they were at all logical, they would carry their protective system much farther; the United States, for instance, should not only have a tariff against foreign countries, but New York should have a tariff against Massachusetts, and so on, so as to get the utmost benefit from the protective policy. There was not the smallest foundation for the statement that 20,000 men had been thrown out of employment in the sugar industry; at the present moment there was more sugar being refined in the United Kingdom than at any former period, and if there were fewer people employed, it was owing to improvements in the mode of manufacture. Even if there were foundation for the statement, it would not follow that the less employment was due to the bounties given by the foreign Governments, and this question had never been faced by those who had been promoting the agitation against the sugar bounties. Coming to the paper itself, he should like to say that, so far as he could judge, although it was a little less gloomy in its statements than some former papers by Mr. Bourne, still, on the whole, there was a tendency to too much gloom, both in the facts and in the anticipations put forward. For instance, in speaking of the iron trade, he threw doubt on the suggestion that the home consumption had increased. Now he had occasion, some time ago, to look somewhat narrowly into the figures, and satisfied himself that from October to the end of December, there had been an increase of something like 25 per cent. in the home consumption of iron; for although the foreign shipments had decreased, the increased stock, as compared with the same period of last year, was very small, so that the immense increase in the production must have been nearly all absorbed in various manufactures at home. With regard to the cotton trade, Mr. Bourne said that stocks were supposed to be accumulating in the East; but, as far as he could discover from trade circulars, those stocks were extremely well absorbed into consumption. Another fact, from which he seemed to draw a gloomy conclusion, was, that last year there was no increase of exports to Australia; but he recollected very well, that two or three years ago, when our exports to foreign countries were diminishing, those to the colonies, and partly to Australia, were increasing. It was hardly fair to expect every year to show an increase to every country in the world; there must be ups and downs, and there might be special circumstances which lowered the export to Australia in one particular year; and they might be well satisfied with the increase which had taken place in our Australian trade during the last nine or ten years. With regard to the main question, he must take exception to the apparently exaggerated importance attached to foreign trade; and he did not agree that in matters of home trade what one man gained must necessarily be at the expense of another; as a rule, every exchange which took place was to the mutual benefit of both parties. He believed the home trade, and not the foreign, was really the important matter. Mr. Bourne also seemed to found his anticipations for the future on the assumption that trade revived more quickly than it went back, and that when it began to revive, the highest point was soon reached, and he gave as an instance the period of the Franco-German war. Now he took exception to that altogether. The revival of trade there referred to, did not commence after the war, but long before, and was in full swing when the war broke out. He remembered noticing the revival of trade which took place in Lancashire in the autumn of 1869, and 1870 was really a very prosperous year, so much so, that when the war broke out, it caught the Stock Exchange in the full swing of speculation, and the result was a panic, unprecedented in the memory of the present generation. The proper year, therefore, to compare with 1880, was 1870. It was very likely that the present revival had been unusually rapid; but whether it would soon attain its maximum, and give place to a reaction, was a question which he agreed with Mr. Walford it would not be wise to discuss with too much obstinacy on one side or the other. They could never be sure, with all the pains they might take to form an absolutely correct anticipation of what would happen. According to past experience, there was reasonable ground for supposing that business would go on improving, but it would be foolish to attempt to predict with certainty. Some of the political causes for not expecting a very favourable result he thought Mr. Bourne had dwelt too much upon, for instance, the political troubles in India and at the Cape. The amount of money involved, though large, was very small when compared with the magnitude of our commerce. The succession of bad harvests had probably had much more influence. He would conclude by expressing his entire approval of Mr. Bourne's remarks with respect to the state of speculation at the present time, especially in securities. There could be no doubt that the advance, which was the cause of so much satisfaction to many people, was only a change in the nominal expression of wealth, and represented no real increase. People were really no richer than they were before, and one of the dangers of the future was the length to which the speculator might go.

Mr. Bourne, in reply, regretted that the main purport of his paper had not received more consideration. The point for consideration was what lessons for the future could be drawn from the past, so that their operations might be guided accordingly; and he must remind the meeting that, having previously written several papers, which would be found collected in a volume in the Library he had now omitted many points with which he had before dealt. For instance, he had fully considered the question raised by Mr. Hill with regard to the influence of freight on the value of exports and imports; and on the present occasion, his object being to compare one period with another, the figures being on the same basis throughout, their absolute accuracy was not of importance. The purchasing power of money was much too large a question to say anything useful upon at that late hour. His object had not been to give a gloomy view, but to put the facts fairly before the public, and he must congratulate himself that he had been the means of directing attention to the real state of the case, which had not been without some advantage in the influence it had had on the conduct pursued. He looked with a great deal of suspicion on the progress of our trade, and a great deal of the political economy of the present day, but, as for looking with any depression on the condition of England, he did not. He only wished to point out the sources from which she might arrive at a grandeur and wealth far beyond what she had ever achieved. The two great requisites were the study of economy and an attempt to follow the American example by taking in our outlying territories, moving our population east, west, north, and south, and embracing in the sphere of our cultivation those portions of our dominion which would furnish prosperous and comfortable homes to those who were now in poverty and destitution. He had no pretensions to prophecy; he only reasoned on the past, to show why it justified an anticipation of the future, and wherein present circumstances differed from past, so that we might learn how best to meet that which was coming. This was the same as was now done with regard to the weather; we obtained information from America of what was passing there at the moment, and from that

drew conclusions as to the weather we might shortly expect in Europe. If he had dwelt more upon the gloomy side, it was because it was more important to guard against possible evils, than to look out for coming prosperity. He had no belief in cycles or the sun-spot theory; but there was the fact, that alternate periods of the inflation and depression had hitherto occurred pretty regularly, and this led many people to suppose that the same thing must happen again, and so speculate largely on the the first indications of a revival; and it was this he wished to guard against, as it led to artificial inflation and a corresponding depression which need not otherwise occur. When he said that the rise was more rapid than the fall, he alluded to this influence. He was glad the Chairman agreed with him that the speculation at present going on was excessive; he feared it would produce an inflation, for which they would suffer severely afterwards. He could not now discuss the question of free trade, but it must be remembered that the circumstances of England differed so greatly from other countries, that we must needs follow a different policy. Here we had a population which we could not feed from our own stores; while America had a population which could not consume half of what she raised. As to the statement that we wanted an extension of trade, rather than an expansion, that was the argument he had constantly enforced; we wanted to enlarge our sphere of operations. With regard to the periods he had selected, 1872 was the period of highest elevation, and 1879 that of the lowest depression, and, therefore, he thought they were fairly selected. Mr. Liggins regretted that so much of our colonial sugar went to New York, but for his part he thought if we could get good customers in any part of the world it was matter for congratulation. The question of exports and imports he had treated fully elsewhere. He was surprised at the Chairman thinking he had taken too gloomy a view, but as he had already said, his only object had been to guard against possible evils, on the principle that forewarned was forearmed. Still, he could not take the cheerful view which was adopted by many writers at present. All the writings of the day seemed in favour of speculation, and that led to the inflation, which caused a subsequent depression. With regard to the home consumption of iron, he had taken the figures from trade circulars. The assumed make and the annual export did not leave a sufficient balance to account for the enormous home consumption which was generally assumed.

The Chairman said the exports were very large in the early part of the year, and the increased consumption at home was mainly in the last three months.

Mr. Bourne said he had only quoted the absolute figures. At any rate, he thought the exports of iron were likely to fall off. With regard to the troubles in India and the Cape, it was not altogether the amount of expenditure to which he referred, but to the fact that we had been killing our customers rather than encouraging them. The question of the morality of the proceedings was one which he would not attempt to enter upon. He was glad that Mr. Giffen endorsed what he said about speculation, for it was that they had most to fear at present. The belief that the trade must necessarily advance by leaps and bounds, was likely to produce a vast amount of that evil, and the growth of the speculative spirit in the present day had raised up and maintained a large portion of the community, who, instead of being producers, were living on the labour of others; and this was one of the most disastrous things connected with trade which could happen. No language could be too strong to condemn the fact of our having in our midst such a large number of non-producers, who did nothing whatever to add to the wealth of the country, but simply by passing goods from hand to hand, and stimulating purchases to an undue extent, absorbed from the honest labourers a large proportion of their gains. This was one of the most fatal elements in the present constitution of our trading society, and the one most necessary to guard against.

Votes of thanks to Mr. Bourne and the Chairman concluded the proceedings.

CORRESPONDENCE.

SIGNALLING BY MEANS OF SOUND.

In reference to Mr. H. P. Babbage's letter which appeared in the last number of the *Journal*, I have only to say that the proposal of the late Mr. Charles Babbage received the most careful consideration in 1851, but the experience of the Elder Brethren of the Trinity-house, as practical seamen, was quite opposed to its suitability or indeed practicability, for the distinguishing lights of lighthouses.

As regards its application to sound signals, Mr. H. P. Babbage does not appear to have any adequate conception of the requirements of the mariner, of the ineffectiveness of such a system for the purpose, nor of the difficulties, expense, and risk to navigation which would be involved by its introduction in place of that now in existence.

All practical seamen condemn any system which necessitates exceedingly accurate and strained observation. When the mariner's mind is full of anxiety, his vessel labouring under the influence of a strong wind and high sea, he does not then desire to have to count laboriously the flashes, the occultations or sound blasts, in order to assure himself of his position. Especially at such a time would the numerical system be liable to mislead; any of the signals may be temporarily obscured by steam, by the rolling of the vessel, or by a passing ship. Suppose the master reads 323 for 333 and pursues his course on the supposition that the light is No. 323, what would be the consequence of such a mistake?

The late Mr. Charles Babbage, as a distinguished mathematician, was naturally very familiar with the language of figures, and, probably, Mr. H. P. Babbage inherits something of his father's proclivity. To such gentlemen, and, indeed, to most landsmen looking at a chart, it would appear that the simplest plan would be to number every lighthouse and every sound signal, and cause it to indicate that number continually. Nothing could apparently be easier or more effective. But they seem to forget altogether that the figures themselves would not be exhibited to the mariner; he would see only flashes, or occultations, or hear blasts, of which he would have to interpret the meaning, at times when, as I have before indicated, all his energies would be required for the management of the ship itself, and when he would be especially liable to make a mistake.

It is almost time that this controversy came to an end, so often has it been shown that the arguments of the advocates of refined distinctions are fallacious. What is really wanted is extreme simplicity, regarded from the mariner's point of view, not from the point of view of the mathematician, electrician, or any other landsman. Each signal must proclaim to the mariner, in as short a time as possible, its own character, so that he may at once recognise it. That is the object aimed at by the lighthouse authorities at the present time, and that it is efficient, and adapted to the requirements of navigation, is acknowledged by all practical seamen who make use of our coast signals, and is only called in question by those whose experience has not made them acquainted with the practical necessities of the case.

E. PRICE EDWARDS.

London, 26th January, 1881.

SUGGESTIONS FOR PREVENTING LONDON SMOKE.

In last week's *Journal* (28th January), in Mr. Moncrieff's paper on the above-named subject, he refers to the Royal Arsenal Gas Works as having practically adopted his scheme of "using fuel, from which a certain proportion of gas only has been extracted."

As I was not present at the meeting, and unaware that Mr. Moncrieff intended referring to the works under my charge, I beg to be allowed to refute the statements in his paper, in so far as they relate to the Royal Arsenal, or any other of the Government gas works.

Some years ago, during an exceptionally busy period, when the Government departments were working all night, I was unable to meet the greatly increased demand for gas, and was therefore compelled, at that time, and occasionally since, to work a few ovens with four-hour charges, so as to obtain a larger quantity of gas in the 24 hours than could possibly be obtained by means of the ordinary six-hour charges, but it is quite a mistake to suppose, as might be inferred, that I only obtained 3,333 cubic feet per ton of coal carbonised, or that the short extraction was effected cheaply owing to the coke from the short time charges "being greatly superior to ordinary gas coke," and thereby assisting the operation, seeing that in the ovens worked with the four-hour charges a volatile cannel coal was used, the coke from which contained very little heating properties, and consequently was not used as fuel under the retorts; and so far from "superiority of the short-time charges being proved," as stated, the plan was found to be very expensive and uneconomical, and was only resorted to in order to meet a few exceptional emergencies; and it is not likely to be adopted again, seeing that the works have recently been enlarged to such an extent that I shall be able at all times in future, by working six-hour charges, and taking all the gas I can get out of the coal, to keep a sufficient stock on hand to meet the requirements of the departments, under any conditions that are ever likely to arise.

I must, therefore, on behalf of all the Government gas works under my superintendence, disclaim any right to the credit given of having adopted Mr. Moncrieff's scheme of producing coke containing a large quantity of gas, as I am sure the War Department would be far from satisfied if, instead of producing, as at present, between 9,000 and 10,000 cubic feet of 16-candle gas per ton of coal carbonised, I were to give them about one-third of this quantity, and to offer a greatly increased yield of tar in lieu thereof, with coke from which only a small proportion of the gas had been extracted.

J. A. C. Hay.

Royal Arsenal, Woolwich,
29th January, 1881.

P.S.—Mr. Wallace, who manages the Royal Arsenal Gas Works, under my superintendence, assures me that he did not furnish the statements contained in Mr. Moncrieff's paper in regard to these works, and that they have been made without his knowledge or consent.

J. A. C. H.

The paper read last Wednesday, by Mr. W. D. Scott-Moncrieff, on "Suggestions for Preventing London Smoke, and making it commercially available," assumes that if the 4,000,000 tons of coal used in London for heating purposes were all put into the retorts of the gas companies (in addition to the coals now used by those companies), and manipulated, as he suggests, London would be a "smokeless city," and an annual saving of some two millions sterling effected. Mr. Scott-Moncrieff asserts that if the gas companies extracted only one-third the quantity of gas they now get out of a ton of coal, the coke, or "smokeless fuel," would have a heating capacity of fully 20 per cent. greater than common coal, and 10 per cent. greater than coke; but we are not favoured with any statistics to prove this, against which I will take the lecturer's own figures—the paper assumes a commercial aspect—how is it then that if coke has a heating capacity of 10 per cent. in excess of coal, its commercial value is 25 per cent. less—coke being valued at 12s. per ton, against 16s.? I venture to think this question should be treated in a practical manner, and taking Mr. Scott-Moncrieff's figures, I submit the following, from a gas maker's point of view:—

Present Nett Cost of Coals for making London Gas.

2,000,000 tons of coal, at 16s.		£1,600,000
Labour thereon, at 2s.		200,000
		£1,800,000
Less tar and ammonia, at 3s. 9d. per ton of coals	£375,000	
1,000,000 tons of coke, at 12s. ..	600,000	
		975,000
Nett cost of coal under present *modus operandi*		£825,000

Mr. Scott-Moncrieff proposes that, instead of using two million tons of coal, the gas companies should use six millions.

6,000,000 tons of coal, at 16s.		£4,800,000
Labour thereon, at 2s, ...		600,000
		£5,400,000
Tar and ammonia is valued at double present sales, or 2s. 6d. per ton of coals	£750,000	
And if no more coke were used for carbonising "in the retorts, on an extraction of less than three hours, instead of six hours, at present prevailing," there would be 3,000,000 tons of fuel for sale, which I cannot value at more than 10s. per ton	£1,500,000	
		2,225,000
Nett cost of coal under proposed new system		£3,175,000

I may add, in passing, that Mr. Scott-Moncrieff calculates 17 cwt. of coke made per ton of coals under the proposed system, against 13 cwt. as at present, with a per-centage used for fuel only, $19\frac{1}{2}$ against 23 at present. I submit that not more than, if so much, as 10 cwt. of coke per ton of coals would be left for sale by the more frequent charging of the retorts.

Mr. Scott-Moncrieff assumes that, by making only one-third of the quantity of gas now made per ton of coal, the illuminating power would be raised from 16 to 24 candles, *i.e.*, 50 per cent., and that the gas would be worth 50 per cent. more money, or 5s. 3d. per 1,000, instead of 3s. 6d., an increase of 1s. 9d. per 1,000, which the consumers would be called on to pay.

I don't think this requires more than a passing notice. A gas consumer, with two burners in his room or shop, can use a third if he chooses to increase his light. Why does he content himself with two? Simply because he does not want to pay for the third or extra light.

We have not been favoured with facts from actual workings, and I think the members of the Society of Arts would like to be informed.

1st. Whether a 16s. coal, producing 10,000 cubic feet of 16-candle gas, will produce at the consumer's burner 3,333 cubic feet of 24-candle gas; 2nd, where and when has the test been made, proving that the coke of 3,333 gas "has a heating capacity of fully 20 per cent. greater" than the coal from which the gas has been extracted.

At the Beckton Gas Works, a year or two ago, there were literally mountains of coke which was unsaleable in London, and had always to be given away in shipment to the Continent. The severity of the last two winters has kept coke stocks pretty clear. Is it to be assumed that the "smokeless fuel" proposed to be made will command a better sale than the ordinary gas coke? I think it may be taken for granted that such fuel exposed for a few days during the recent weather, would have become a heap of rubbish on removal from the gas works.

According to my figures, London, instead of having four million tons of coal and one million tons of coke for fuel, would have to be content with three million tons of "smokeless fuel," and the gas companies saddled with an increase of £2,350,000 in the cost of producing their gas.

R. H. Jones.

Sydenham, 31st January, 1881.

KITCHEN BOILER EXPLOSIONS.

Having regard to the number of kitchen boiler explosions occurring at the present time, many of them attended with fatal consequences, it might perhaps be of service if you could find room for the following in your columns.

Lavington E. Fletcher.

Instructions for a Placard.

On the recurrence of frost, it might be well to have placards printed in large clear type and posted in prominent positions in the public thoroughfares or other suitable places, explaining to the public the best means of preventing kitchen and circulating boiler explosions.

Text for Placard.

Manchester Steam Users' Association on Kitchen and Circulating Boiler Explosions.

Kitchen boiler explosions are due to an accumulation of pressure in the boiler, in consequence of the outlets being stopped up while the fire is burning. These explosions occur during the frost through the choking up of the pipes with ice. Sometimes stop-taps are placed in the circulating pipes, and should these taps be shut, or should the circulating pipes become choked with sediment, or stopped up from any other cause, the pressure would then be bottled up, and an explosion might result at any time, whether summer or winter.

To prevent this, every boiler should be fitted with a small reliable safety valve, whether the boiler be of copper or cast-iron, and whether it be fitted with a copper cylinder or not. A safety valve of dead weight construction is recommended as the most simple. In the event of the outlets becoming choked, it would relieve any undue pressure and prevent an accumulation, while at the same time it would emit a slight hissing noise, which would tell those in the kitchen that something was wrong.

In the meantime, until a safety valve can be fixed, open the hot-water tap in the bath-room, and any other hot-water taps connected with the boiler. If the water cannot be drawn freely from these taps, do not light the fire, and if the fire be already lighted, put it out at once. If the water flows freely, the fire may then be lighted, but this must be done with caution, and the taps just described frequently opened to see that the flow continues, and that the water gradually heats. If the flow does not continue, or if the water does not heat, the supply of water to the boiler must be running short, or something must be wrong with the circulation, and the fire must be drawn. Also the cold-water cistern as well as the ball-tap should be examined, and the cold-water taps in the bath-room, and elsewhere, opened to see that the water supply is free, otherwise the boiler may run dry. When the fire is once lighted, and the circulation proved to be free, the fire should be kept burning by night as well as by day as long as the frost lasts, otherwise the frost may get the master during the night, choke the pipes with ice, stop the circulation, bottle up the pressure, and thus lead to the bursting of the boiler. But the only true safeguard is a reliable safety valve, and the sooner that is fixed to the boiler the better.

Lavington E. Fletcher,
Chief Engineer.

9, Mount-street, Albert-square, Manchester,
January, 1881.

P.S.—The Manchester Steam Users' Association has nothing whatever to do with the manufacture or sale of the dead weight safety valve recommended; but it may be of convenience to the public to state that one made in accordance with the association's drawings may be obtained for 10s. 6d. at Messrs. Isaac Storey and Sons, Cathedral-yard, Manchester.

NOTES ON BOOKS.

Report upon certain Museums for Technology, Science, and Art; also upon Scientific, Professional, and Technical Instruction, and Systems of Evening Classes in Great Britain and on the Continent of Europe. By Archibald Liversidge. (Sydney, 1880.)

In 1878, Professor Liversidge, of the University of Sydney, was desired by the Colonial Secretary of New South Wales, and also by the Chancellor of the University of Sydney, to collect information respecting the technological and industrial museums, institutions, schools, &c., of Europe, for the guidance of the Board of Trustees appointed to found a Technological and Industrial Museum at Sydney. The result of Mr. Liversidge's investigations are contained in this report. The first part contains accounts of the museums in London, Edinburgh, Oxford, and Exeter, of the Conservatoire des Arts et Metiers, Paris, and of the Italian Industrial Museum, Turin. The second part is devoted to the various institutions where scientific and technical instruction is given. Of these, forty-three are situated in Great Britain and Ireland, eight in Austria, four in Belgium, forty-one in France, fourteen in Germany, three in Holland, four in Italy, two in Russia, two in Sweden, one (the Polytechnic School, Zurich) in Switzerland, and one (the Massachusetts Institute of Technology, Boston) in the United States. The appendix contains a list of publications relating to Technical Education, &c., and a synopsis of Lord Stanley's circular upon Technical and Industrial Education to her Majesty's representatives abroad, with their replies (1868).

Trade, Population, and Food: a series of Papers on Economic Statistics. By Stephen Bourne. (London, George Bell and Sons, 1880.)

In this volume the author has arranged a series of his papers on cognate subjects, published at various times in the proceedings of societies, so as to form a connected whole. Under the first head, the progress of trade is dealt with, and special attention is drawn to the question of the growing preponderance of imports over exports. The second division relates to population and the social aspects of trade depression. One chapter is specially devoted to the finance of national insurance, in which the practicability of the measures that have been proposed for the prevention of pauperism are investigated from a financial point of view. The third division is devoted to the subject of food supply, in which "Duties on Wine," and "Drinking and Depression" are considered. The result of Mr. Bourne's conclusions are as follows:—"The needed explanation then, of the phenomenon manifested in the growing expansion of our imports beyond that of our exports is simply this, that with a prosperous state of trade and manufactures, the

mouths we have to feed, and the food required to feed them have increased beyond the powers of our own soil to provide for; and that other nations have been growing in intelligence, wealth, and manufacturing power, and so in the capacity for supplying their own wants, without increasing, but rather decreasing, their demands upon those products of our labour by which our ability to purchase food from them is largely maintained. Our necessities have been multiplied by continuous seasons of diminished produce from our own soil, whilst agricultural operations have been progressively advancing abroad."

A Smaller Manual of Modern Geography. By John Richardson, M.A. (London, John Murray, 1880.)

This book is compiled on the same plan as the "School Manual" of the same author, and is intended for junior classes. It is not merely an abridgment of the larger work, but contains matters which was considered superfluous there. The introduction contains some general notices of astronomical or mathematical, physical, and political geography.

GENERAL NOTES.

Ceara-rubber.—Information concerning the plant which produces Ceara-rubber is contained in the report on india-rubber by Dr. H. Trimen, of Ceylon. The plant is very hardy, and will grow in a dry, rough soil, and a moderately dry, hot atmosphere, while the Para and West India rubber plants require a rich alluvial soil, and a constantly hot moist atmosphere. Ceara-rubber plants have been found to succeed in Ceylon, Calcutta, and Madras, but the climate of Singapore is too wet for them. It is suggested that plantations should be formed on exhausted coffee land. The tree grows to about thirty feet or more in height, and forms a dense rounded crown. It attains a diameter of four or five inches in about two years, when it may be tapped.

Domestic Sanitation—Dr. Richardson, F.R.S., will deliver a course of nine lectures on "Domestic Sanitation or Health at Home," before the Ladies' Sanitary Association, in the Hall of the Society of Arts, on the Saturdays, from February 12th to April 9th. The subjects dealt with in these lectures come under the heads of (1) food and digestion, (2) the healthy circulation of the blood, and the means of keeping the organs of circulation in a healthy state, (3) respiration and the allied subject of ventilation. A first prize of ten guineas and a second prize of five guineas, offered by Edwin Chadwick, Esq., C.B., will be awarded to the two competitors who have most distinguished themselves by a knowledge of the subjects taught in the lectures. Dr. Richardson will also give first and second-class certificates of attendance and proficiency to students who wish to compete for them.

City Technical Institute.—The programme for the spring term of the City Technical Science Classes has been issued. Professor Armstrong, Ph.D., F.R.S., and Professor Ayrton, A.M. Inst. C.E., will continue the courses of instruction in chemistry and physics as applied to the arts and manufactures, at the Cowper-street Schools, Finsbury, in rooms rented from the Middle Class School Corporation, pending the erection of the City and Guilds Technical College, Finsbury. In the evening Chemistry Classes, Dr. Armstrong will lecture on "Organic Chemistry, with special reference to its Industrial Applications." The chemistry of the coal tar products, their uses, and the production of dyeing materials from them will be very fully considered. The chemistry of brewing, spirit distilling, and vinegar-making processes will form the subject of the lectures after Easter. Dr. Armstrong will deliver a course of lectures for junior students, introductory to the practice and theory of chemistry, on Thursdays, from 12 to 1 p.m., commencing January 27th. The chief object of these lectures is to afford such preliminary training as is necessary for those who may desire later on to study particular branches of applied chemistry, but the student's attention will be specially directed to the technical bearings of the subject. He will also give a course of lectures on "Coal Gas, and its uses as an Illuminating and Heating Agent." A junior introductory course will also be given; and there will also be laboratory classes and a Photographic Chemistry Class. In the Physical Class, Professor Ayrton will give courses of lectures on "Electrical Instrument Making," "Electric Light," "Motor Machinery, with especial reference to Electric Lighting," and the "Electric Transmission of Power." In this department also there will be laboratory and junior classes.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

FEBRUARY 9.—"The Present Condition of the Art of Wood-carving in England." By J. HUNGERFORD POLLEN. Sir PHILIP CUNLIFFE-OWEN, C.B., K.C.M.G. C.I.E., will preside.

FEBRUARY 16.—"The Participation of Labour in the Profits of Enterprise." By SEDLEY TAYLOR, M.A., late Fellow of Trinity College, Cambridge.

FEBRUARY 23.—"The Manufacture of Aërated Waters." By T. P. BRUCE WARREN.

MARCH 2.—"On Lighthouses Characteristics." By Sir WILLIAM THOMSON, LL.D., F.R.S.

MARCH 9.—"Improvements in the Treatment of Esparto for the Manufacture of Paper." By WILLIAM ARNOT, F.C.S.

MARCH 16.—"Buying and Selling; its Nature and its Tools." By Prof. BONAMY PRICE, M.A. Lord ALFRED S. CHURCHILL will preside.

MARCH 23.—"The Increasing Number of Deaths from Explosions, with an Examination of the Causes." By CORNELIUS WALFORD.

MARCH 30.—"Recent Advances in Electric Lighting." By W. H. PREECE, Pres. Soc. Tel. Eng.

APRIL 6.—"The Manufacture of Glass for Decorative Purposes." By H. J. POWELL (Whitefriars Glass Works).

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at eight o'clock:—

FEBRUARY 22.—"The Languages of South Africa." By ROBERT N. CUST.

MARCH 15.—"The Loo Choo Islands." By Consul JOHN A. GUBBINS.

APRIL 5.—"Trade Relations between Great Britain and her Dependencies." By WILLIAM WESTGARTH.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings, at eight o'clock:—

FEBRUARY 24.—"Deep Sea Investigation, and the Apparatus used in it." By J. G. BUCHANAN, F.R.S.E., F.C.S. Captain Sir GEORGE S. NARES, R.N., K.C.B., F.R.S., will preside.

MARCH 24.—"The Future Development of Electrical Appliances." By Prof. JOHN PERRY.

The meeting previously announced for April 7 will be held on May 12.

INDIAN SECTION.

Friday evenings, at eight o'clock:—

FEBRUARY 11.—"Gold in India." By HYDE CLARKE. Sir WILLIAM ROBINSON, K.C.S.I., will preside.

MARCH 4.—"The Results of British Rule in India." By J. M. MACLEAN.

MARCH 25.—"The Tenure and Cultivation of Land in India." By Sir GEORGE CAMPBELL, K.C.S.I., M.P.

MAY 13.—"Burmah." By General Sir ARTHUR PHAYRE, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

CANTOR LECTURES.

Monday evenings, at eight o'clock:—

The Second Course will be on "Watchmaking," by EDWARD RIGG, M.A. Three Lectures.

Syllabus of the Course.

LECTURE I.—FEBRUARY 7.

Introduction—Units of Time—Historical Sketch—Description of usual forms of watch—Escapements—Conditions of accurate timekeeping, and arrangements necessary for their maintenance in the higher class of watch.

LECTURE II.—FEBRUARY 14.

The ordinary watch—Degree of accuracy required in it—Systems of manufacture in this country and abroad—Description of specimens illustrative of the various stages of construction—Comparison of the several systems.

LECTURE III.—FEBRUARY 21.

Necessity of efforts to promote the art in this country Need of education, theoretical and practical, in horology—Literature—Great want of uniformity in gauges, screws, &c.—Exhibition of ordinary and complicated watches, and of watchmakers' tools—Conclusion.

The Lectures will be illustrated by Specimens, Models, and Diagrams. The different movements, &c., will be shown enlarged on the screen by means of the Aphengiscope and the Electric Light.

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. ADAMS, F.R.S. Four Lectures.

March 7, 14, 21, 28.

The Fourth Course will be on "The Art of Lace-making," by ALAN S. COLE. Three Lectures.

April 25; May 2, 9.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. BRUDENELL CARTER, F.R.C.S. Three Lectures.

May 16, 23, 30.

ADMISSION TO MEETINGS.

Members have the right of attending all the Society's meetings and lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEB. 7TH... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Edward Rigg, "Watchmaking." (Lecture I.)
Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. J. Bailey Denton, "The Management of Rivers."
Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Presentation of the premiums awarded during the past Session, by the late President, Mr. Joseph Bernays. Inaugural Address by Mr. Charles Horsley, President.
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on Mr. Joseph Lucas's paper, "Rural Water Supply, with Special Reference to the Objects of the Public Health (Water) Act, 1878."
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Dr. S. Kinns, "The Truths of Revelation Confirmed by the Advance of Science."
London Institution, Finsbury-circus, E.C., 5 p.m. Sir H. S. Maine, "Succession to Thrones."

TUESDAY, FEB. 8TH...Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. A. Schäfer, "The Blood." (Lecture IV.)
Central Chamber of Agriculture (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. C. Colson, "The Portsmouth Dockyard Extension Works (2nd Part)." 2. Mr. C. H. Meyer, "The Plant and Temporary Works Used on the Portsmouth Dockyard Extension."
Photographic, 5A, Pall-mall East, S.W., 8 p.m. Annual General Meeting.
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.

WEDNESDAY, FEB. 9TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. J. Hungerford Pollen, "The Present Condition of the Art of Wood-Carving in England."
Graphic, University College, W.C., 8 p.m.
Microscopical, King's College, W.C., 8 p.m. Annual Meeting for Election of Council and Officers.
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sidney Colvin, "The Amazons." (Lecture IV.)
Sanitary Institute of Great Britain, 9, Conduit-street, W., 8 p.m. Mr. W. H. Michael, "The Law in Relation to Sanitary Progress."

THURSDAY, FEB. 10TH...Telegraph Engineers and Electricians, 25, Great George-street, S.W., 8 p.m. Mr. Alex. J. S. Adams, "Earth Currents—Electric Tides."
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m Prof. Monier Williams, "The Castes and Trades of India."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. Francis Hueffer, "The Troubadours." (Lecture IV.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Mr. E. B. Elliott, "Some Theorems of Kinematics on a Sphere." 2. Mr. J. W. L. Glaisher, "Some Integrals expressible in the terms of the first complete Elliptic, and of Gamma Functions." 3. Herr Schlöttel (Strasburg), "Mr. McColl's Calculus of Equivalent Statements."

FRIDAY, FEB. 11TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8½ p.m. (Indian Section.) Mr. Hyde Clarke, "Gold in India."
Royal United Service Institution, Whitehall-yard, 3 p.m. Lieut.-Col. C. R. Sherrington, "Army Transport."
Royal Institution, Albemarle-street, 9 p.m. Dr. R. S. Ball, "The Distance of the Stars."
Astronomical, Burlington-house, W., 8 p.m. Annual General Meeting.
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m. Annual Meeting.
Folk Lore Society, 22, Albemarle-street, W., 8 p.m. Rev. W. S. Lach-Szyrma, "Folk Lore Traditions of Historical Events."

SATURDAY, FEB. 12TH...Ladies' Sanitary Association (at the HOUSE OF THE SOCIETY OF ARTS), 5.30 p.m. Dr. B. W. Richardson, "Domestic Sanitation or Health at Home." (Lecture I.)
Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Annual General Meeting. 2. Special General Meet-3. Dr. O. J. Lodge, "A Hydrostatic Illustration of Electrical Phenomena, and other Lecture Experiments."
Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Sidney Colvin, "The Amazons." (Lecture V.)

ERRATA.—Page 161, col .1, l. 51, *for* sulphates, *read* sulphides; p. 161, col. 1, last line, *for* tons, *read* ounces; p. 161, col. 2, l. 9, *for* Anderson, Longmead, Augustin, or Rhodin, *read* Henderson, Longmaid, Augustin, Ziervogel, or Rhodia; p. 161, col. 2, l. 10 from bottom, *for* mills, *read* metals; p. 162, col. 1, l. 36, *for* or about 46 to 60 per cent., *read* only about 46 to 48 per cent.; p. 162, col. 1, l. 38, *for* 26 per cent., *read* 96 per cent.; p. 162, col. 1, l. 10 from bottom, *for* miner, *read* mine; p. 162, col. 2, l. 18, *for* everybody engaged, *read* everybody could not engage.

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FRIDAY, FEBRUARY 11, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

NOTICE TO INSTITUTIONS.—EXAMINATIONS.

The attention of Secretaries of Institutions in Union with the Society, is directed to the Programme of Examination sent to each Institution with this week's *Journal*, especially to paragraphs 6 to 10. Institutions desirous of using the elementary papers issued by the Society, are reminded that application for them should be made at once. See page 7 of the Programme.

CANTOR LECTURES.

The first lecture of the second course was delivered on Monday, 7th inst., by Edward Rigg, M.A., on "Watchmaking." The lecturer gave a historical sketch of the subject, and described the usual forms of watch escapements, conditions of accurate timekeeping, and arrangements necessary for their maintenance in the higher class of watch.

The lectures will be published in the *Journal* during the summer vacation.

TELEPHONE EXCHANGE.

The offices of the Society of Arts have lately been connected with the Telephone Exchange, the head offices of which are situated in Coleman-street, E.C. Any member of the Society, whose place of business is also connected with the Exchange, can thus communicate with the Society. The Society's offices are connected, in the first instance, with the company's Exchange in Chancery-lane, and this can be put into communication with any other station from which wires radiate to the various places using the Exchange system. The offices are also connected by a private wire to the Society's printers in Fleet-street, the company's telephone being now used instead of the Wheatstone A. B. C. instrument, which had previously been employed on a Post-office wire for the same purpose.

HOUSE SANITATION.

The Council offer the following Medals for the best Sanitary Arrangements in Houses built in the Metropolis, the plans of such arrangements to be exhibited in the Society's Rooms, Adelphi, in June, 1881, and to be sent in on or before 12th May, 1881:—

1. One Silver Medal for the best sanitary arrangements, carried out and in satisfactory working, in a house let out in tenements to artisans, for which a weekly rental is paid.

2. One Silver Medal for the best sanitary arrangements, in actual working, in a house of the yearly rental of £40, or less, to about £200 in value.

3. One Silver Medal for the best sanitary arrangements, in actual satisfactory working, in a house of the yearly rental value of £200 and upwards, to any amount.

4. The houses must be open to the inspection of the Judges, who, in considering their award, will be guided by the suggestions of plans for main sewerage, drainage, and water supply, made under the Public Health Act, 1875.* The houses must have been in actual occupation within the last three months, and a Certificate must be given by the occupiers, on a printed form, stating the satisfactory working of all the sanitary arrangements, such form to be obtained at the Society of Arts.

5. The houses may be old, fitted with modern sanitary arrangements, or may be new. They must be within the metropolitan area of the Board of Works.

6. The sanitary arrangements must include the conditions for good water supply, drainage, warming, and ventilation of the house, and precautions taken against frost.

7. The medals may be awarded to the occupiers of the houses, or the lessees, or the owners.

8. The plans must consist of a ground plan and sections, to the scale of not less than one inch to five feet; details of not less than one inch to the foot. The plans may be accompanied by specifications.

9. The names of the architects, surveyors, or sanitary engineers who directed the sanitary arrangements should be given, and Certificates will be awarded to those whose plans obtain the Medals. (By Order)

H. Trueman Wood, Secretary.

* The Public Health Act has been revised to 1878, and published by Her Majesty's Stationery Office. Price, with plans, three shillings.

DOMESTIC ECONOMY.

1. The Council will hold a Third Congress on Domestic Economy, at the Society's Rooms in the Adelphi, London, during the present year.

2. The Council offer Seven Bronze Medals, and Certificates of Merit for Papers (not exceeding 1,000 words), written by Teachers of Public Elementary Schools and Training Colleges, which shall give an account of the best method practised by the teacher, of the teacher's experience, and the result of the teaching, in any one or more of the seven classes of subjects named below.

3. The Education Department, in the Code of 1880 (p. 31), classes the following subjects under Domestic Economy for Girls:—

The First Branch includes—

(a) Clothing and Washing.
(b) The Dwelling—Warming, Cleaning, and Ventilation.
(c) Rules for Health—The Management of the Sick Room, Cottage Income, Expenditure, and Savings.

The Second Branch includes—

(a) Food—Its Composition and its Nutritive Value
(b) Food—Its Functions.
(c) Food—Its Preparation and Culinary Treatment (*i.e.*, Practical Cookery) (§ 24).

The Council have resolved to add the subject of Needlework, which will be exhibited and discussed in the Congress, although it is not classed in the Code as a branch of Domestic Economy.

4. Only one medal will be given to a teacher, but the subjects taught successfully will be inscribed on the one medal and a certificate given.

5. The papers must be sent to the Secretary of the Society of Arts by the 1st May next. Each paper must be enclosed in a sealed envelope, bearing a motto, and must be accompanied by an envelope bearing the same motto, and having within it the writer's name and address.

6. No medals or certificates will be awarded if the papers are not of sufficient merit to deserve them. (By order)

H. TRUEMAN WOOD, Secretary.

LABEL FOR PLANTS.

The Council are prepared to award a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary not later than the 1st May, 1881.

The Council reserve to themselves the right of withholding the Medal and Prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

PROCEEDINGS OF THE SOCIETY.

FOREIGN AND COLONIAL SECTION.

Tuesday, February 1st, 1881; Sir RICHARD TEMPLE, Bart., G.C.S.I., C.I.E., D.C.L., in the chair.

The paper read was on—

THE INDUSTRIAL RESOURCES OF SOUTH AFRICA.

By the Right Hon. Sir Bartle Frere, Bart., G.C.B., G.C.S.I., F.R.S., D.C.L., LL.D.

When first proceeding to South Africa, I found the greatest difficulty in obtaining any reliable detailed and recent information regarding its industrial resources, and the same difficulty has struck me since my return to England, when I have been often questioned on the subject by those whose attention had been directed to the English possessions in that quarter.

Much that is valuable is to be found well selected and well arranged in Mr. Silver's excellent handbook,* but there is much which could hardly be compressed into any single hand-book, and though I cannot pretend to supply the want, something may be done towards assisting others to do so, if I briefly state, in the course of the present lecture, a few of such facts connected with the industrial resources of the country, which strike a traveller in South Africa, and if I refer to sources whence more detailed information may be obtained by those who desire it.

I have no striking new facts to communicate. I can give you little more than a traveller's impressions, pointing out where my own information has been derived, and offering to answer any questions on the subject which my hearers may wish to address to me after the lecture has concluded.

I must presuppose a general knowledge of the physical configuration and extent of temperate South Africa, and the relative position and general area of the component States, and I must ask you to remember that temperate South Africa is a very large territory comprising:—

1st. The Old Cape Colony, in which may be now included Kaffraria, Basutoland, and Griqualand West.

2nd. The Colony of Natal.

3rd. The Orange Free State.

4th. The Transvaal.

* Silver's "South Africa." Third edition. Silver and Co., Sun-court, 67, Cornhill. Price 5s.

5th. The Transgariep and Damaraland. Regarding the area and population of these provinces, I would beg to refer to the paper I lately read before the Royal Geographical Society, which will be found printed, with a useful map, in the January number of the Proceedings of that Society.

You will bear in mind the various character of the population. Of Europeans we have large numbers, of diverse origin. English, Dutch, with a large sprinkling of French Huguenots, an increasing number of Germans, and scattered representatives of most other European races. Of men of African race we have those distinguished as the "red" or "yellow skinned races," who claim to be the aborigines of the country, including Bushmen, Namaquas, and Hottentots, and men of "black," or rather dark brown complexions, chiefly of the great Bantu family, including Kaffirs, Zulus, Bechuanas, and Damaras. Of mixed races we have Griquas and others, besides important classes of Asiatic origin represented by those known as "Malays," men of Javanese race at the Cape, and "Coolies" of Tamul and other Indian races in Natal.

Regarding the seasons and meteorology of the country, I can only briefly here notice that for the most part South Africa lies, as they would say in India, between two monsoons, or trade winds, neither of them throughout the greater part of the territory very regular, but influencing the general climate, and themselves much modified by the sweep of the mountain ranges, which run parallel to the sea coast, and rise by successive terraces to the high land in the interior. To the west there is a generally dry summer and a wet winter, to the eastward we have wet and thundery summers and dry winters. In all cases, we must remember that the seasons of summer and winter are the opposite to those belonging to our own northern hemisphere.*

As to the history of this country, I will only now refer you to the standard works of Mr. John Noble, Mr. Theal, and the excellent school abstract of Mr. Wilmot.†

The political constitution of a country is of course a most important factor in all industrial questions, but I can dwell no more on this point than to remind you that the Cape Colony has representative institutions, with a Ministry responsible to the Legislature; that Natal has representative institutions, but no responsible Ministers; and that the Transvaal is a Crown colony with a nominee Legislature, all three being under the British Crown. The Orange Free State has an independent republican Government, with a president and volksraad, in alliance with, but quite independent of, the surrounding British colonies.

Those who would desire to know more on the subject of the various constitutions, may consult besides Mr. Silver's hand-book, the almanacks and directories of the Cape Colony, Natal, and the Transvaal, all excellent in their way.‡

The public income and expenditure would naturally require notice, but, at present, I must content myself with referring you to the works I have just mentioned, and to the enclosed papers, which will be printed as an Appendix (B) to this lecture, merely noticing a few salient points in passing.

So with regard to trade and commerce, you will find excellent general abstracts of parliamentary papers in the works I have already mentioned, to which the papers forming Appendix C, will furnish a few additions.

I will now consider, in brief detail, under several heads, the chief industrial resources of the country.

Mineral Resources.

As regards mineral resources, the first place is claimed by coal. It has long been known that considerable coal fields existed in the South African colonies, but, so far as I can learn, there is, in this country, a very inadequate conception of the extent and value of the fields already known; and the researches which have hitherto been made have shown that the known coal fields form but a very inconsiderable portion of those which exist between the sea and the tropic. There appears no reason to doubt that from the neighbourhood of Beaufort West, in the Cape Colony, where the railway from Cape Town at present terminates, coal is to be found in the neighbourhood of both sides of the great line of mountains which follow the direction of the coast from the Nieuwvelt Mountains, in lat. 32° S., at least as far as the Oliphants River, in lat. 24° S., and extensive beds are known to exist north-north-eastward from the Transvaal, being on the surface at more than one part of the Zambesi Valley and appearing also on the surface on the Ravooma River.

But let us now consider more in detail the coal in the Cape Colony. Promising indications of coal have been found in the Nieuwvelt and Camdeboo Mountains, where boring operations are now going on under the Cape Government, and coal is now extracted to a considerable amount at more than one spot between the line of railway from Port Elizabeth to Graaf Reinet and Basutoland. In the Stormberg Mountains, and about Molteno and Dordrect, in the Indewe Valley, the seams are said to be easily accessible and productive, and appear to be of great extent, but the commercial value of these fields can hardly be ascertained until railways, which have now been constructed up to Beaufort West, Graaf Reinet, Craddock, and Queenstown, shall be further extended.

In the Orange Free State, there appear to be vast deposits of coal between Bloemfontein and the Upper Vaal River, in the neighbourhood of Cronstadt and Winburg; and the reports of Mr. Stowe, a trained geologist, have justified expectations of finding most valuable and extensive fields in the north-eastern portion of the Free State. In a letter dated 6th September last, Mr. Stowe

* Vide Appendix A.

† Printed by Clowes and Son, London, for Juta, Capetown.

‡ "Cape of Good Hope General Directory," Saul Solomon and Co., Cape Town, sold by White, 17, Bloomfield-street, London. "Natal Almanac, Directory, and Register," sold by Algar, 11, Clement's-lane, Lombard-street, and by G. Street, Cornhill. "Jeppe's Transvaal Almanac," which is full of useful information, as is his excellent map. "Emigrants' Guide to South Africa," second edition, 1880, price 1s., White and Co., 17, Bloomfield-street, London. There is an "Emigrant's Guide to Natal," published by Lockwood and Co., Stationers'-hall-court, Ludgate-hill, full of useful and accurate matter, as might be expected from the author, Dr. R. J. Mann, F.R.A.S., F.R.G.S., formerly Superintendent-General of Education in Natal. It was, however, published as far back as 1867. It is much to be wished that Dr. Mann would revise it, and bring it up to date. Much later information regarding the colony is to be found in the larger work, "Brook's Natal," edited by Dr. Mann, and published by Reeve and Co., 5, Henrietta-street, Covent-garden, in 1876.—B.F.

states that he has obtained the refusal of mining rights in 24 square miles of country in the heart of the thickest deposits. Magnetic iron is within 15 miles of coal beds, sometimes upwards of 12 ft. thick.

In Natal, coal has been for some time worked to a considerable extent at Newcastle and Dundee, and indications have been found in other parts, as at Estcourt; but these deposits are not likely to be developed till means of carriage are improved. I have been informed by Dr. Mann, that he found, when he was at Pietermaritzburg, that he could get coal cheaper from England *via* Durban than he could from the field that had then been recently discovered in the neighbourhood of Newcastle. The Newcastle beds, which I visited, appear to extend to a great distance, and to improve in quality in an easterly direction towards Zululand. Before he advanced from Kambula, Sir Evelyn Wood furnished fuel to a great part of his column for a considerable time, from surface beds which he discovered near the then Zulu boundary, and it is clear that these Natal and Zulu beds are of very considerable extent.

On the north-western side of the Drakensberg, beds re-appear, apparently continuations of those above described in the Orange Free State. At Standerton, I found the people habitally using, as their fuel, coal which they carted from an open surface pit a few miles distant; and indications of coal are met with both to the north towards Lydenberg, and westward down the valley of the Vaal River.

At present, all these fields are but little worked, owing to want of means of cheap carriage, but at some places, as at Kimberley, the price of fuel is so enormous as to render it possible to bring this coal in wagons from a distance of several hundred miles. Between Potchefstroom and Kimberley, I overtook several wagons of coal, containing four tons each. It was being brought as a speculation from surface mines between Potchefstroom and Heidelberg, and could, I was told, be sold at a profit after this long cartage at Kimberley; but then it must be remembered that £17 was no unusual price for a wagon load of firewood at Kimberley, so that any substitute could bear long carriage. We may hope that Kimberley will before long be better supplied with means of transport, by which coal can be brought both from the seaboard and the interior. In that case, some cheaper and more powerful means of transport than a bullock wagon must be found, if the Transvaal coal is to be profitably worked. The country is open and well adapted, not only to railroads, but for navigable canals, which could be most easily and cheaply constructed from any part of the Upper Vaal River to Kimberley.

At present, South Africa is entirely dependent for its supply of iron on imports from other countries, but there is abundance of iron ore in the vicinity of coal-beds, easily procurable and easily worked, and only waiting a supply of cheap transport and abundant fuel to enable it to be worked to advantage.

Manganese has been found in several localities. There are mines which have been for some years profitably worked near Wellington, in the western Cape Colony.

Cobalt has been found in rich and easily-worked mines north of Middelburg, in the Transvaal, and indications have been discovered to the south of the Drakensburg, in Natal.

Lead mines of great richness have been worked at Marico. I met four wagons laden with pigs of Marico lead near Pretoria. The mines have been worked and the lead extracted by Mr. Bray, an enterprising Englishman; and here again better means of carriage were all that was needed to render the mines of great value.

Valuable copper mines have been worked for some time in Little Namaqualand, and the exports of copper ore from Port Nolloth to Swansea are of great annual value. When the mines were first worked in 1854, a copper mining mania prevailed in the Cape Colony. Thirty companies, to dig for copper, were formed, with nominal capital amounting to £1,393,000. Many were ruined by the subsequent crash, and only one copper mining company survived. The average yield from 1858 to 1867 was 4,000 tons of ore.

The railway from Port Nolloth to Ookiep (93 miles in length), has since been constructed by the Copper Mining Company, and the average yield is valued at about a quarter of a million sterling per annum. Still, richer mines are said to exist beyond the British boundary in Damaraland, where a considerable amount of almost pure native copper is found and worked by the Bushmen and wild tribes north of the Damaras.

Great expectations were, at one time, formed of the richness of the Transvaal gold fields, and a considerable amount of gold is even now extracted from the gold fields in and beyond the Lydenberg district about Pilgrim's Rest and Macmac. Much more would probably be worked if the country were settled, but here and in other parts where gold has been worked, as, for instance, in the mountains between Pretoria and Potchefstroom, the gold hitherto found has been, for the most part, in quartz, and cannot be extracted without more machinery and cheaper fuel than the miners have as yet been able to command. To the north and north-east of the Transvaal there are said to be very productive gold fields, from the best portions of which miners have hitherto been excluded by the jealousy of native chiefs. But if I may trust the opinions which have been given me by gold miners of considerable experience in California and Australia, there is some danger that the accidental discovery of a really good field might at any time induce an influx of gold diggers, who would not be content till they had removed all difficulties, political as well as physical, which at present limit this branch of industry.

The great and increasing diamond mines in Griqualand West and the Orange Free State would require more than one lecture to do justice to a subject of such importance. I can only, therefore, here remind you of a few salient facts. It is only fourteen years since the first diamond was discovered in South Africa, and the exports since then have so enormously increased, that in one year more than three and a half millions pounds worth of diamonds have passed through the Cape post-office, besides diamonds of a very large value which were exported in other ways. The principal mines, I need hardly tell you, are at Kimberley. They are found in what appear to be the remains of extinct subaqueous craters, formed by the

escape of fluid mud and gases which have forced outlets through the sandstone and other strata, on what is now the surface, but which seem, when the craters were formed, to have been under a great depth of water. The subterranean forces have formed vast craters, more or less regular in shape, and which, till the diamond digging commenced, were filled up with fragments of rock more or less altered by subterranean heat, and with a blue volcanic indurated clay or tufaceous mud, such as is still ejected from the active mud volcanoes on the Mecran Coast, between Persia and India. In such indurated clay, the diamonds are found embedded. The clay is of stony hardness when first dug out, but rapidly decomposes under the influence of the atmosphere, acting on the sulphate of iron with which it is largely charged, and the precious stones are then easily washed out.

Besides diamonds of every variety of colours and water, garnets and similar stones are found, which are hardly noticed at all by those who are collecting the diamonds, but the collection of which may ultimately form a branch of industry. The old Kimberley Mine, which has now reached the depth of 300 feet without any indication of either the supply or the quality of diamonds failing, is a very regular shaped crater. The adjoining mines of Du Toit's Pan, Old de Beers, and Bultfontein, are more irregular in shape, and have been less deeply excavated; but it appears, from the discovery of diamonds in other "pans," as they are called (*i.e.*, depressions indicating outlets of subterranean forces), which are found in various parts of the adjoining country, that the Kimberley mines are by no means singular in the riches which they contain. The Jager Fontein diggings, near Fauresmith, in the Orange Free State, are already largely worked, and we hear of other mines being opened in the neighbourhood. But, besides the "pans," or "dry diggings," as they are sometimes called, where the diamonds may be supposed to be found *in sitû* in the indurated clay which embeds them, diamonds, some of them of the finest water and of great value, have been found in alluvial or "river diggings," near the banks of the Vaal and other rivers. They appear to have been washed out of their original matrix, and deposited with gravel in the alluvial soil near the present course of the river. The working of these alluvial mines is more laborious, owing to the great size of the boulders which have to be removed, and the return for the industry expended on them is less certain, as the diamonds are found very irregularly distributed—sometimes many together and sometimes none at all—but, when found, they are generally valuable stones, as imperfect stones, and stones liable to split on exposure, are less commonly met with than in what are called the dry diggings, in the old craters.

Time does not admit of even brief notice of the mining communities, which have settled at the diamond fields. A very graphic account of the fields will be found in Mr. Anthony Trollope's "Western South Africa." His description, though full of valuable matter, is not always drawn with a flattering pencil. I have extracted from the *South African*, and added as an Appendix* to this paper, a very useful and succinct description of the Diamond Fields, by Mr. R. W. Murray, who has been long resident there, and who knows the fields and their inhabitants as well as any living authority.

* Vide Appendix D.

I may here mention that about a century and a half ago, London was the chief seat of the art of cutting diamonds; but the industry was subsequently removed to Amsterdam, which, till lately, had a monopoly of the business. It has since been restored to England by Mr. W. Ford, of Clerkenwell-green.* An account of the mode of splitting a diamond, with an illustration of the tools used, is given in the late Rev. Arthur Rigg's Cantor Lectures on "Tools" (*Journal*, vol. xxiii., p. 820).

We are indebted to Professor Tennant for a beautiful collection of South African diamonds and other gems, which he has allowed to be exhibited here this evening.

Fine specimens of asbestos have been brought from the Asbestos Mountains in Griqualand; and agates, cornelians, garnets, &c., though they do not form objects of industry, have been collected of considerable value, and probably would well repay more careful research. They are found in the river gravel in all parts of the lower course of the Orange River, nearly down to its mouth.

Good slate is found in various parts of all the colonies, but English slates are cheap and good. The local slate quarries cannot be worked without an abundant supply of labour and capital, and the slates used are consequently for the most part imported. It is the same with regard to marble, which has been found of good quality near Worcester, and in some of the southern portions of Natal. Of good building stone and brick earth there is no want, and with the exception of timber, building materials are almost everywhere cheap and abundant. Porcelain clay, of very good quality, has been found in the neighbourhood of Cape Town, and a factory has been set up for pottery.

Salt is largely produced in the Transgariep territories, and the salt-pans west of the Vaal and Hart Rivers are of considerable value even now.

Before quitting the subject of the mineral resources of South Africa, I may be allowed to bear my testimony to the general accuracy of the indications of mineral resources given on the face of Jeppe's map of the Transvaal. I confess that, before I went to the Transvaal, I was sceptical on the subject, but wherever I had opportunities of testing the information so given, I found that the minerals mentioned by Jeppe were always to be met with, though of course, not always in quantities to pay the expense of mining.

Guano, though of animal origin, may be mentioned here as an object of colonial industry. It is produced on the rocky islets on the West Coast, where there is little rain. Most of the old deposits, on Ichaboe and other islands, have been long since cleared away, but there is a considerable amount of fresh deposit yearly, from the myriads of seabirds which frequent the coast in the breeding season, after which, the guano is swept together and collected. The groups of rocks and islets, twenty in number, are leased for various periods of from 5 to 26 years, at a total

* Vide Appendix D.

annual rent of £2,410, besides the dues levied on the guano collected. The quantities collected during eight years, averaged more than 2,000 tons of guano per annum, valued at £6 per ton, besides sea fowls, eggs, feathers, and fish oil, to an average further value of £2,255 per annum. (Cape Parliamentary Return, 1880.)

Agricultural Resources.

Let us now turn to the agricultural resources of South Africa. Let me, in the first instance, state that from Durban, round by the route which Sir George Colley is now following to Pretoria, and thence, *via* Potchefstrom, to Kimberley and Beaufort West, and so by railway to Cape Town, a course of not less than twelve hundred miles, besides other visits to the Kaffir frontier and many districts between Port Elizabeth and the Baashi River, I have seen enough of South Africa to gain a very good general idea of the character of its soil and other requisites for agriculture. Throughout the whole distance I have travelled I find it difficult to recall more than a mile or two at a time of barren and unfertile country. Mountains there are, and stony wastes, where there is barely food for more than a very small number of sheep to the square mile; but, of hopelessly unprofitable land, except on the mountain ranges, it is difficult to find more than a few patches here and there. On the other hand, the country abounds in long stretches of extremely fertile land, such as would be valued in any country in Europe, and with every variety of climate similar to what would be met with in the northern hemisphere, from the extreme north of the temperate zone to the semi-tropical regions of Northern Africa. In parts, especially in the Transvaal and on the coast, the pasture for large cattle is extremely rich and abundant, and further away from the coast the country is admirably adapted for sheep farming. It is a peculiarity of South African pasturage that it is as often found upon shrubs and bushes as among the grasses of the field. Some of the districts where the Merino sheep flourishes best, possess hardly a blade of grass, but there is abundance of food to be found in the shoots of various plants, chiefly aromatic in scent, and adapted by habit to resist long droughts. On these the sheep thrive, and can produce as good wool and mutton as upon any downs in England or Spain.

Water is abundant in most parts of South Africa, to the extent required by the farmer. It is not always on the surface, indeed, in many vast regions, it is very rarely to be seen on the surface, and such districts have hitherto, in many cases, been accounted barren and uninhabitable, except for a few months after rain; but the farmers are now becoming alive to the fact that, below the surface, even in portions of country which have hitherto been supposed to be quite arid and unprofitable, water is generally to be found by digging at moderate depths; and I can testify, from my own observation, that, in many districts where want of water is now much complained of, it could be found if the people would only expend on well-digging the ordinary amount of labour which is required for agricultural existence in most parts of Central India, Rajpotana, and the Deccan. But there is a still greater field for increasing the present water supply by means of canals, which might, to an enormous extent, be drawn from the rivers in almost every part of the country. Much has been already done on a small scale by farmers; and on some of the large farms in the Karroo, I have seen thousands of pounds expended by farmers in what are locally called dams, or reservoirs formed by embankments across valleys, and by what are called "leading furrows" from running streams.

For wells, and for such small works of irrigation from streams, the country may, I think, safely trust to the enterprise and capital of individual farmers; but I hope the time is not far distant when the Government in South Africa will turn its serious attention to large schemes of irrigation from the great rivers with which the country abounds. It is not necessary to go to Africa for the purpose of satisfying one's self of the immense returns which would follow such a system of large irrigation works from some of the more considerable streams, on the scale of which every province in India affords so many examples. If we look, for instance, at either the Orange River or the Vaal on any large map, we see the course of large perennial rivers, which carry an abundant supply of water even in the driest months of the year, and after the most prolonged droughts. They are fed, in fact, from springs in the great ranges parallel to the coast, which never fail to have a supply of annual rain, however much the low country may suffer from the want of it. These streams run in the earlier part of their course frequently over rocky beds, affording every facility for dams such as are required to turn the course of the stream into channels excavated at the side. A very short distance of such excavation would suffice in almost every case to lead the water clear of the deep river bed on to the level of the country around, which has a gradual slope, generally westward and northward, enabling a canal to be carried for hundreds of miles over undulating country, which appears as if made for artificial irrigation, continuing down the course of those great rivers to within about 100 miles of the great Atlantic Ocean.

On a smaller scale, the facilities of most other rivers which have a course northward or westward from the great mountain backbone of the continent are quite equal to those of the Orange River and the Vaal. Even the sandy river beds which traverse so much of the Karroo might be turned to valuable account by works of the kind I have indicated. All these river beds are the channels of a flooded stream once or oftener during the course of most years, and carry, during such temporary floodings, a vast quantity of water which now runs to waste into the ocean. In any part of India such streams would be utilised by making them give a thorough soaking to a dry plain at some distance down the valley, or they might be made to fill artificial reservoirs which are formed by damming up the lower extremities of hollow valleys, and they would thus furnish, if not water for cultivation, certainly the water required to maintain large flocks of sheep and cattle.

As a rule, the streams which run south and east from the Drakensberg, and the other ranges which run parallel to or in continuation of that great mountain chain, are less promising subjects for irrigation engineering, on a large scale. They

generally have a course of steeper gradients, and flow in deep and comparatively narrow valleys. But even on these, there is ample room for the profitable expenditure of a large amount of capital. To some, attention has already been directed, as to the Sunday River, between Port Elizabeth and Grahamstown. The Breede, the Berg, the Oliphants River, and many others which might be named, flow through a country covered by valuable farms, the value of which might be far more than doubled by inexpensive irrigation works on a comprehensive scale, though very little has as yet been done to take advantage of the natural resources which these streams afford.

Time does not admit of more than a very brief description of the various breeds of cattle. There are some native breeds which have valuable qualities of their own. The small and hardy Kaffir and Zulu cattle are valuable for their meat and milk. The Damara cattle are of larger size, and have larger horns, approaching more nearly to the Africander breeds, which appear to be a cross between European—probably Dutch—cattle and those which were found in the possession of the Hottentots when the Dutch first arrived in the country. Of late years much has been done, with some success, to introduce the more valuable and improved breeds of Europe. On most large farms of the more intelligent class of farmers, some of the best English breeds have been tried, with varied success. Shorthorns, however excellent in other respects, are rather less hardy, and more delicate in constitution, than the breeds of the country. Alderney and Kerry cows are generally to be found near large towns, where milk is in demand; but with very few exceptions, it can hardly be said that any very systematic attempts have been made to improve, by crossing, those breeds which experience shows are most valuable in the country. It must be remembered that at present, and probably for some generations to come, the quality of cattle for draught will materially influence the views of the South African cattle breeder. Railways will, I trust, rapidly extend, and the horse and mule wagon will come into increased use; but the ox wagon is, in so many respects, adapted to the country where no good made roads are to be found, that it will be a long time before it is entirely superseded by quicker modes of transport.

Horses.—The Cape has long been celebrated for the excellent quality and cheapness of its horses. They appear to have been originally of Spanish, or Barb, stock, and in this respect resemble the breeds of South America; but, for some time past, and especially since Lord Charles Somerset was Governor, great efforts have been made to improve the original breeds, by means of importations of the best English stock. Most parts of the old colony, except the warmest of the coast districts, seem admirably adapted by nature for horse breeding. Breeders from Australia, as well as from England, generally object to the small amount of shelter and artificial food which is allowed to the mares and colts, and consider that the Cape system of treating breeding stock is more rough and less artificial than they would approve. I do not pretend to pronounce any opinion myself on this point, but any visitor to the Cape who may wish to see horse-breeding on a large scale, as managed by some of the most intelligent and successful of Cape stock-breeders, should apply to Mr. Melk for permission to visit his farm on the Berg River, about 90 miles to the north of Cape Town, where they would have opportunities of seeing South African cattle-breeding in its greatest perfection.

The Cape Colony was almost entirely swept of its best stock of horses by the demands consequent on the Indian Mutiny in 1857, when a great number of horses of the best breeds were exported to India. A time of considerable agricultural depression followed, and it can hardly be said that Cape stock has yet recovered from the depletion of 24 years ago; but this is more owing to the enormous demand caused by purchasers from the interior than from any falling off in the production of stock. The establishment of the Orange Free State and Transvaal republics, and the opening of the Diamond Fields, greatly increased the former demand for horses in the interior, and to this, more than to any falling off in the production, must be attributed the present scarcity and dearness of horses in the best breeding districts of South Africa.

Mules are, in some respects, even better adapted for purposes of draught than either oxen or horses in South Africa, and increasing attention is being directed to the breeding of this kind of stock, but it does not yet meet the demand, and many hundreds of mules are annually imported at present from South America.

Sheep are, as in Australia, one of the staple resources of the South African farmer. The sheep of the country is, as I need not tell you, a very different animal from any European breed; long-legged, with hair instead of wool, and with the enormous fatty tail which distinguishes many of the African breeds of sheep. It must be a very ancient breed, for I have seen onyx images of the black-headed Berbera sheep which is common in North-East Africa, the black head and white body of the sheep being imitated in the black and white of the onyx. These images were found in Egyptian mummies at least 2,000 years old, and resemble the sheep put on board the P. and O. ships at Aden. The Hottentot sheep has its merits, owing to its extreme hardiness and power of resisting privations of food and water, which would destroy almost any other breed; but, except for its meat and its skin, the Hottentot sheep is of little value as compared with any European breed. Men are still living who have had the honour of introducing Merino sheep, or some cross from Merinos, into their own district, and good stories are still told of old-fashioned farmers who, on the first introduction of the Merino breeds, derided the foolish adventurers who offered to pay them for the privilege of "cutting the hair off their sheep;" but such stories relate to a past generation, and at present every South African farmer is alive to the value of his wool-bearing sheep, and keen in discussing the best means of improving them. There is, however, a great want of scientific intelligence among many sheep-farmers as regards the diseases of sheep, the evils of overstocking, and of too frequent shearing, careless breeding, and insufficient shelter and food at lambing time. The Cape Colony is still behind Australia in the attention it has paid to the prevention of scab, by enclosure laws,

Scab Acts, Acts for the extirpation of burr weeds, such as the *Xanthium spinosum*, and other legislative provision for protecting the improving sheep-farmer from the results of his neighbours' carelessness or ignorance. The water supply is a question, of course, of primary importance to the sheep-farmer, and increased attention is every year being paid to means of providing water for sheep pastures by well-sinking and pumping. There are probably millions of acres in South Africa which might be turned into profitable sheep-walks by the irrigation engineer, the well-sinker, and the English manufacturer of inexpensive means of raising water by machinery.

Angora goats are, I believe, of comparatively late introduction, the first having been brought to the colony by Mr. Mosenthal. They appear to thrive in most of the drier climates of the colony, and this branch of industry is likely to receive annual development as the means of transport in the colony improve.

Ostrich Farming.—Time does not admit of my saying more than a few words on this new and most profitable branch of industry. It is but a very few years since the idea of taming the birds which thrive wild in most parts of South Africa, occurred to an intelligent colonist, and when I first went to the Cape, ostrich farming was still looked upon as rather a fancy occupation, not quite worthy the notice of a steady-going, old-fashioned farmer; but the extraordinary profits which have since been realised, have produced a kind of mania on the subject, and in every part of the old colony ostrich farming is very rapidly extending. I have seen some farms where the stock was obtained quite recently by securing broods of wild birds accidently found on the estate; but the production of eggs, and the hatching young chicks for sale, is now a recognised branch of farming industry in almost all parts of the western province. There are very few parts of the country which are naturally unfitted for rearing ostriches, and there are some districts, such, for instance, as the extensive unreclaimed bush lands to the north and east of Grahamstown, which appear peculiarly adapted to ostrich farming, and which have hitherto been almost unprofitable for anything else. The birds require, probably, less artificial food than any other stock of equally productive value. Cuttings of prickly pear, the great white arum, almost every kind of succulent vegetable, maize, and millet, besides the natural food they find at large, appear to suit them, and if they have ample space to move about in, they seem very little liable to artificial diseases. To watch them, to hatch the eggs, and to rear the chicks, require very little more than the ordinary constant attention which would be needed for looking after domestic poultry, while the returns, whether from eggs, young birds, or feathers, are very great with reference to the proportion of outlay, either of land, capital, or labour. But, like every other kind of farming, to render it a success, it requires careful and continuous, patient, personal attention, and many young adventurers whom I have seen going out to Africa expecting to invest a few hundred pounds in ostrich farming, and to live like gentlemen on the proceeds, without care and trouble to themselves, are, I am afraid, doomed to disappointment. I must refer to published works for detailed descriptions of the manugement of the birds, which is full of interest and amusement to those who are fond of domestic animals. I will only notice one peculiarity of ostrich farming, that when tried on an exhausted sheep-walk, it is found that a few years of use as an ostrich run restores land which has been exhausted by over-stocking, and renders it again capable of feeding a suitable number of sheep. I have often been asked whether I thought the present demand for ostrich feathers would last. I could only reply that the liking for such feathers was one of the few points on which the taste of the most barbarous savage agrees with that of the civilized races; that a perfect ostrich feather, like a good precious stone, is a beautiful thing in itself; and that the fashion for wearing ostrich feathers has endured among great people for more than 4,000 years, as is shown by the sculptures of Assyria and the paintings of royal tombs in Egypt.

Before leaving the subject of stock breeding, I would ask attention to the hope, which seems justified by the success of ostrich farming, that the science and patience of some future South African agriculturist may turn to account the good qualities of some of the indigenous animals, which are fast disappearing from South Africa, and also enrich the South African farmer by further importations of foreign domesticated animals. For instance, there can be little doubt that wherever the African buffalo thrives, there the Indian buffalo, which is so valuable for milk, and for heavy draught, and so inexpensive to keep, would be found to thrive; and it is more than probable that if proper pains were taken, the African buffalo, or a cross from it, might be domesticated. There are also, among the llamas and alpacas of America, and the wool-bearing goats of Europe and Asia, other animals besides the Angora goat which would be found profitable. I am aware that experiments have already been made in this direction, but as far as I could learn, they failed, not from any natural incapacity of the country to support the imported animal, but from some defect in management.

So, with regard to camels, there can be no doubt whatever, I think, that the Arabian or Asiatic camel would thrive quite as well in South Africa, as it does north of the Sahara Desert and in Somali-land, and would be a most valuable addition to the means of transport in many parts of South Africa. I, myself, made an attempt at importation; owing to its arrival at the rainy season, and the impossibility of attending to the animal after its arrival, the attempt was not successful; but nothing could be better adapted to the camel than most parts of the Karroo country, which I have seen, and it would probably be still more valuable in the sandy tracts near the Kalahari Desert, and north of the Orange River.

Attempts have been already made by the Khedive of Egypt and Colonel Gordon, to utilise the elephants of northern Africa, as they were, no doubt, made use of by the Carthaginians and Romans. The king of the Belgians has spent large sums in similar attempts in Central Africa. The African elephant is fast disappearing. In the old Cape Colony, a few are still carefully preserved in the forests round Knysna, where H.R.H. the Duke of Edinburgh shot one, and in the Adda Bush

between Port Elizabeth and Grahamstown; but it is further to the northward, I think, that it might be worth the while of enterprising speculators, as well as of the Government, to make experiments on a large scale, with a view of ascertaining whether the indigenous aboriginal elephant could not be made as useful for purposes of carriage and draught as in India or Ceylon. I have heard from colonial hunters well authenticated stories of the destruction of scores of elephants at a single battue, when they had been driven into deep marshy ground on the borders of Lake N'Gami; and not a wild elephant is now to be found within many hundred miles of the places where, within my own memory, Sir William Harris and Gordon Cumming saw elephants in herds to the number of hundreds in one day. There are parts of the present colonies where, no doubt, a tamed elephant might thrive and be profitably used, and from the Tugela northwards there is probably very little of the coast country where they would not supply, to a great extent, the present want of efficient means of carriage.

It may not be out of place that I should mention the possibility that some of the less productive farms may, at no distant period, be turned to account as game preserves, like the red deer forests in Scotland. I know gentlemen, such as Mr. Alexander Vanderbyl, who have enclosed promontories on the southern coast, containing some thousands of acres, where they have preserved the indigenous antelopes of the country, and can offer a day's shooting, comprising at least six kinds of African antelope, besides the partridges, bustards, and pheasants, as they are called, of the country. The bush-buck, the rai-buck, and the duiker appear, wherever a tract of bush is allowed to rest without much intrusion from woodcutters. The spring-bok appears periodically in such multitudes, in the districts bordering on the Orange River, that I have seen applications to Government that the farmers might be allowed to destroy the bucks in the close season, as a means of preventing their eating up the sheep pasture; almost every species of African antelope will thrive and multiply in enclosed tracts, if only preserved from destruction by the sportsman.

Time does not admit of more than the briefest possible allusion to the resources for arable farming in South Africa. As a general rule, it may be said that, with the exception of garden lots, very few farms are cultivated to the full extent of which they are capable. This is partly owing to the abundance of land, partly to the old colonial love of isolation, and partly to the want of adequate supplies of capital and labour. But on every hand are seen evidences of progress and improvement. The old Dutch plough, and the old fashion of trampling out the grain, are giving way to the newest ploughs by Ransome, Howard, and other European and American makers. The steam plough has been imported and used. Many farmers in the western provinces use reaping and thrashing machines, and mowing machines have been introduced into Natal. But these things are to be seen only here and there, at rare intervals, and only a beginning has been made of improved farming on scientific European systems.

It is very rarely that an attempt has been made to meet the uncertainty of the seasons, by saving hay or roots for feeding cattle, though in most parts of the country oat hay is cut and stored for forage. But a very large field is open for improvements in all these branches of farming.

So with regard to cerials. On wheat-lands the the finest crops of wheat are apt to suffer from rust, but I doubt not some scientific farmer of the future will introduce kinds less liable to this disease.

Millets in all varieties seem at home, as well as Indian corn — or "mealies" — in every part of South Africa, but some of the best kinds of Indian and American origin have not yet been tried.

Vines are among the established agricultural resources of the western colony, but little has been done to improve on the old methods of vine growing and wine making brought to Africa by the original settlers.

In Appendix E will be found a memorandum, with which I have been favoured by Mr. Goodliffe, describing steps lately taken for the improvement of wine farming and wine making in the Cape Colony; and I have no doubt that a new era is before the South African wine grower, more especially if the wine duties in England are remodelled on the principles lately recommended by the Select Committee of the House of Commons.

The fact that Cape wines gained prizes at the late Paris Exhibition shows that, when properly managed, they will yet bear comparison with European vintages.

We have yet to notice many valuable articles of semi-tropical produce, for which the warmer regions of temperate South Africa are well adapted. Natal has already established a name as capable of producing coffee and sugar. Of coffee, the crop in 1870 was 960 tons; since then the production fell off, chiefly owing to want of experience and knowledge of the best mode of treating the plants, and is only now again on the increase. The causes of this temporary decline will be found described in a memorandum, with which I have been favoured by Mr. Walter Peace, the emigration agent for Natal, and which is annexed as Appendix (F).*

For details regarding the production of sugar, I must refer to the same paper by Mr. Peace. It is said that the last crop will yield 15,000 tons of sugar, of an average value of £20 per ton.

I cannot give a better account of the agricultural resources of Natal, than by quoting the annexed extracts from the address of Mr. W. G. Baker, president of the Pietermaritzberg Agricultural Society, at the annual meeting of that society, in October last, for which also I am indebted to Mr. Peace.*

It will be seen that tea planting has also been tried with success, and that all the smaller articles of semi-tropical produce, such as red pepper, tapioca, and arrowroot, afford profitable returns.

Tobacco is already grown to a great extent in Oudtshorn and other districts of the Cape Colony, and on most good farms in the warmer portions of the Transvaal. Looking to the great and increasing consumption of tobacco in all parts of South Africa, among natives as well as Europeans, there may be no doubt that tobacco may become a great staple of South African agricultural industry.

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* *Vide* Appendix F.

On the great value and necessity for tree planting on an extended scale, and of the immense benefit which a good system of forestry would be to South Africa, I cannot now dwell, nor on many minor resources of industry connected with agriculture, such as the abundance and value of fruit crops of almost every kind suited to a temperate climate, the drying and preserving of which afford profitable occupation to many upland farmers.

Turning now from the land to the ocean, I can only briefly glance at the resources afforded by the fisheries on the South African coasts.

Table Bay, and False Bay, as well as Algoa Bay and Saldanha Bay, were formerly great resorts of whalers, but of late years, this branch of marine industry has fallen of, and though whales are still abundant in the seas of South Africa, the whole fishery is confined to an occasional American ship, the master of which does not always devote his exclusive attention to whaling. The seal fishery also has disappeared, though seals still visit in small numbers the rocky islets in the neighbourhood of the Cape; but there is a large and increasing demand for the fish, which are caught and cured in great numbers in the neighbourhood of Cape Town, as well as along the coast to the northward, and form a large item of export trade to the Mauritius and other places.

On the West Coast, north of Saldanha Bay, there are but two ports at present frequented by sea-going steamers, Walwich Bay, on the coast of Damaraland and Port Nolloth, the port of the copper mining district, just south of the Orange River. Neither affords complete shelter to vessels of any considerable size, nor could either be improved in this respect without the expenditure of a considerable sum of money; but there can be no doubt that much might be done to improve the facilities of landing and shipping on this coast, if it were carerully surveyed, and the natural landing places improved by beacons, lights, and similar appliances.

Harbours.—The coasting as well as the ocean-borne trade of South Africa has been much restricted by the want of good natural harbours. All the large rivers have bars at their mouths, which prevent their being much used for purposes of trade, and, from the Portuguese frontier on the West Coast, in lat. 18°, round to Delagoa Bay on the East Coast, in lat. 26°, with the exception of Saldanha Bay, there is not a single perfectly safe natural harbour where large ships can lie at all seasons, and take in or discharge cargo without inconvenience. Saldanha Bay will, no doubt, in time, be connected with the railway lines in the vicinity of Cape Town, and will become a valuable port. At present, it is hardly ever used, except as a quarantine station. Table Bay is an anchorage secure from easterly and southerly winds, but open to the north and west. Its natural defects in this respect have, however, been, to a great extent, supplied by the breakwater (the first stone of which was tipped by H.R.H. the Duke of Edinburgh in 1860), and which is still in progress of extension. It has already rendered the anchorage safe against the dangers which, in former years, have strewn the coast of Table Bay with wrecks of large vessels. The Alfred Docks have supplied the means of receiving and discharging cargo, alongside a wharf, to all but the very largest class of shipping, and even these will, at no distant period, be accommodated by the extension of the docks and jetties now in progress. Graving docks, slips, and other appliances are also either completed or in course of completion. It is only necessary to carry out the designs of Sir John Coode, in order to enable Cape Town to take its place as a port furnished with every desirable convenience for mercantile marine.

Simon's Bay, an inlet on the shore of False Bay, on the other side of the Cape peninsula, is an anchorage safe at all seasons and in all winds, for ships which are well found in ground tackle, and it has the appliances of a small naval arsenal, but it is deficient in the necessary means for cheap and rapid discharge of cargo, and is as yet unconnected with Cape Town by railway, though only twelve miles distant from the present terminus.

Algoa Bay is an open roadstead, owing its facilities for carrying on trade to its excellent anchorage, and for putting to sea should it come on to blow heavily from the exposed quarters. Everything which enterprise can do has been done to facilitate landing, short of the construction of harbour works, and these, I trust, will not be long delayed, for it is evident to anyone who has paid much attention to harbour improvement that there is an existing trade at Port Elizabeth which would justify such an outlay as is estimated for the improvement of the harbour; and there can be little doubt, from the high character of the engineer, that any sums laid out on the completion of Sir John Coode's plans would be well applied.

Port Alfred, at the mouth of the Kowie River, is a bar estuary, which is being made available for sea-going ships of moderate burden by works which will make this a very useful port.

The same may be said of East London, at the mouth of the Buffalo River. There seems no reason to doubt that Sir John Coode's plans for the improvement of this estuary will be successful, and make it a valuable port for all the Kaffrarian frontier.

The St. John's River, in Pondoland, is a natural estuary, requiring, apparently, harbour works of no great extent, or probable expense, to render it a most useful channel of trade, but the surveys for its improvement have only lately been completed, and no plans have yet been laid out for the harbour works needed to make the bar passable. The anchorage inside is of great extent and perfectly sheltered.

Durban, in Natal, is already a port carrying on a very large trade, though the harbour is readily accessible only to small sea-going vessels; and little progress has been made in removing the bar, which would enable it to accommodate large vessels. These are at present obliged to remain outside, and discharge and receive cargo as in an open roadstead. Various plans have been devised for the improvement of the Durban harbour, and large sums have been expended, with very little effect, chiefly because it is only lately that the authorities have consulted an experienced harbour engineer, with a view to the systematic and perfect improvement of the harbour. Sir John Coode has furnished plans which, I have reason to think, would be approved in all their main features by his professional brethren, and there can be no doubt that Durban might be made an admirable harbour, adapted to

sea-going ships of the largest class, by works not more expensive than those which have converted the port of Kurrachi, in Scinde, from a small coasting port, a little better than a fishing village, into one of the principal ports of the Indian Empire. The resemblance between the two harbours is most striking, and having watched the Kurrachi harbour works from their commencement, and seen the general improvement of the harbour, I cannot but regret the delay which has hitherto occurred in acting upon Sir John Coode's recommendations with regard to the port of Durban.

Delagoa Bay is a good natural harbour, where ships of any size may load and unload in safety, even in the present unimproved condition of Lorenzo Marquez, the seat of the local Portuguese Government. The port is admirably situated for the wants of the Northern and Eastern Transvaal, besides a great extent of fertile coast country in its immediate vicinity. The Maputa River, running south from the bay for 60 miles as the crow flies, in the direction of Zululand, gives valuable water-carriage to Tongaland, whence large numbers of labourers come to work in Natal and the Cape Colony. Other rivers, which discharge into the bay, afford similar facilities, to a less extent, in other directions, the land all around being extremely fertile, and well adapted for sugar and rice. It requires only a settled government, able to protect life and property, for its development. It is a standing cause of complaint with many of those who are anxious for the progress of South Africa, that this harbour was awarded to the Portugese by arbitration, but I would put it to those who wish for the development of trade in this direction, whether it would not be better that we should avail ourselves of the advantages held out by the Portuguese port, rather than indulge in unavailing regrets that the port does not belong to ourselves? Nothing can exceed the liberality of the terms of the treaty concluded by Mr. Morier, H.M. Minister at the Court of Lisbon, with the Portugese Government, and the treaty would probably have been ratified and made use of ere this, had the English mercantile community, who are interested in the development of those countries, shown that they appreciated the advantages held out to general commerce by the treaty, and pressed her Majesty's Government for an early ratification of the treaty by both Powers. The treaty provides that British goods should be admitted free of custom dues in bond; that the English Government should be allowed to build bonded warehouses to any extent; to connect such bonded storehouses by rail with the frontier of the Transvaal; and so to import goods free of Portugese customs through the Portugese territory. No greater facilities in these respects could be afforded if the port were in our own hands, and, judging from what is done elsewhere, there would be no insuperable difficulty in obtaining from the Portugese Government such additional improvements in the facilities for landing and shipping goods at Lorenzo Marquez as English traders might require.

Before quitting this subject of harbours, I would note that I have enumerated only those which are already open to ocean trade. There are others which might be improved at no great expense, and will, I have no doubt, at no distant period, be thriving ports for a considerable local and coasting traffic. Some, like Mossel Bay, are good roadsteads, where a large and increasing trade is already carried on, though the means of landing or shipping cargo depend on the weather. Others, like the Knysna, are already accessible as far as depth of water is concerned, and are well sheltered, but require better communication with the interior through the mountain ranges which encircle the harbour, and such appliances as a good steam-tug, to make the narrow entrance safe for sailing vessels. Others are bar harbours, like the Berg and Breede Rivers, and are at present frequented by small coasting vessels, but might be made accessible, with a considerable amount of inland river navigation, by such works as have rendered so many of our own bar harbours in England available to ocean commerce. But it is only within the last few years that the commercial public in South Africa has been awake to the necessity for such harbour works. I have no doubt that every year will witness further improvement in this respect, bearing in mind the cardinal truths which apply to harbour improvement in every part of the world, that it is waste of money to follow any but the best scientific advice; that the best scientific advice always makes the utmost possible use of natural forces as means of gradual improvement; that all permanent improvements must be gradual, and that no great improvement can be expected, until the whole of the works designed for removing obstacles by the scientific engineer have been completed.

Steamer Lines.—I need not dwell at any length on the great development of steam communication with the Cape, the history of which would alone afford ample materials for a long lecture. It is sufficient to note that the companies of Messrs. Donald Currie aad the Union Company each run during the greater part of the year a large steamer every week, and sometimes two, between the Cape and England, the lines from the Cape being extended to the Eastern ports as far as Delagoa Bay.

While on this subject, I would notice the great field for development of commerce on the western coast, which would be opened by the employment of steamers between Table Bay and the Portuguese possessions. There is already a line of steamers, subsidised, I believe, by the Portuguese Government, and managed by a Hull Company, between England and Benguela, the southernmost port on the west coast belonging to Portugal.* There is already a growing traffic, which affords employment to a small steamer between Cape Town and Walwich Bay. Much more might be done, if the service were more regular, and carried on by better steamers. Even with the present amount of traffic it is probable that a line on this coast would find ample employment, and still more, should a land line of telegraph be carried through Damaraland and the Portuguese possessions as far as the Congo, on the West Coast.

Telegraph Lines.—I cannot here do more than advert briefly to the increasing facilities for commerce afforded by the development of telegraphs. The ocean cable has been lately completed between Durban and Aden, and the network of land lines.

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* *Vide* Appendix G.

has now extended to most of the towns and larger villages in British South Africa.

Railways.—As regards railways, also, I can here only briefly state a few salient points. The total length of lines at present open, or likely to be opened in the course of the next few months, in the Cape Colony, is 959 miles of Government railways, and 98 of line made by the Copper Mining Company. The lines are shown on all the modern maps of the colony, and extend (1) from the Cape Peninsula to Beaufort West; (2) from Port Elizabeth to Graaf Reinet, with one branch to Grahamstown and another to Craddok; (3) from East London to Queen's Town. All these lines are likely to receive early extension from their present termini, till they converge and reach Kimberley and the Orange Free State, and till Grahamstown is connected with Port Alfred at the mouth of the Kowie.

The Natal lines at present extend no further than from Durban to Pietermaritzberg, with short branches parallel to the coast; one running north, the other south. It is a question locally much discussed, whether the Pietermaritzberg line shall be extended in the direction of Ladysmith and Harrismith, or of Newcastle. The total length of rail completed in Natal is 105 miles.

I understand there is a project for a line in continuation of that from Durban to the Tugela, which shall ascend to the east of Zululand, through the country under Mr. John Dunn's chieftainship, so as to tap the coal-fields in that direction.

A line from Delagoa Bay to the Transvaal is of the utmost political and commercial importance, and is not likely to be delayed long after order is restored in the Transvaal. I believe that the extension of the railway system is one of the most potent factors in promoting the peaceful development of all South Africa. The Cape lines hitherto made are paying well, and will, when extended to Kimberley, enormously increase the commercial facilities of the country, without imposing any tax on its finances.

In these brief remarks, I have endeavoured to give to the industrial classes of these islands, through the widely circulated *Journal* of the Society of Arts, some faint idea of the industrial resources of the great country where I have lately sojourned. It is a country with a history, but a history confined to the deeds of men, our kinsmen in blood, and almost of our own times. Many thousand years must have elapsed since the South African continent took its present shape; the great basin of the Orange River and its tributaries, with their diamond fields and gold fields, their deserts, and their fertile pastures; the rock-bound coast; the great mountain ranges, which rise to the Drakensburg peaks, all were, probably, thousands of years ago, as they are now, in outline and climate, in clothing of plant and tree, and in the wild animals which abounded within living memory; there is no evidence of much change in natural form or feature for forty or fifty centuries before Europeans came to colonise. But history there is none of South Africa—save vague traditions, or such records of pre-historic man as bone caves and gravel beds may yield—till we come down to the days when the bold seamen of Portugal planted the cross on each great promontory as they weathered it, and marked the road by which English, Dutch, and French traders might follow them to and from the Indies.

The country has, however, a great history before it, but it is a history yet to be made by the men of European lineage, who have chosen it as their home. As the traveller passes over league after league of almost uninhabited country, and marks the fertility of the soil, the genial climate, the facility of access, and the ease with which all the real wants of civilised European life can be supplied, the questions force themselves on him, how long is this land, so favoured by Nature, to remain so thinly inhabited by civilised man, the heritage of wild animals, or the abode of a barbarism which degrades mankind almost to the level of the beasts that perish?

And then it was impossible not to think of the thousands of civilised, industrious, law-abiding men and women, who, in our northern over-populated country, are wearing out their lives in a ceaseless struggle for a bare existence. It was difficult to resist the conviction that there, in South Africa, was ample room for myriads and myriads of such men to find the means of living, and of rising to comfort and independence, which are daily becoming more difficult of attainment within the narrow limits of our own land.

But for such men as I have described, who may resolve to make South Africa their home, there is, I believe, a higher destiny than merely to live, or even than helping to form a nation.

Thinly scattered throughout the whole region are tribes of various native races, one of whose peculiarities seems to be that they have never settled, never had a resting-place, in any country which, for many generations together, they could call their own. They have no history, save the memory of endless migrations, pursuing or being pursued; as conquerors and exterminators, or as the victims of conquest and extermination. The oldest or most intelligent can but repeat the same dreary memories of how they came from afar—from the northward—from regions where they were a greater, more civilised, and happier people than they are now; how, driven on by other hostile tribes, they sometimes rested for a few generations in the same region, and, under chiefs of superior courage and sagacity, conquered, slaughtered, drove out, or absorbed surrounding clans, only to be in their own turn conquered, slaughtered, or absorbed by some yet stronger and more numerous savages; or driven out of their temporary homes, to resume the ceaseless wanderings of thousands of years past.

Yet are they a people of excellent, physical, and intellectual qualities, many of them far superior to the negroes of Central Africa, and all bearing more or less traces of having been gradually degraded from a state of higher civilisation and more complete humanity. They are capable of receiving and adopting all that we can give them of the arts of peace, the means of civilisation, and those great truths which are the secrets of national and individual happiness here on earth, and the only sure lights in the darkness and mystery of future existence. I have known men of these native races, endowed with natural capabilities in no way inferior to the average of those

who make their mark in intellectual or political careers even amongst ourselves. These are their capabilities. What is needed for their development? Nothing, I believe, but settled order and government—of our modern European civilised type—a Government that can frame laws, and enforce them, which can defend life and property, and enable its citizens, as long as they obey the law, to prosper and advance in civilisation and happiness, each according to his own individual qualities.

Such Governments already exist in South Africa. I have nowhere seen a Government which reproduced as fully and accurately as that of the Cape Colony, the conditions and possibilities of social and political life, which we so value here in England. Such Government is possible under the English Flag, in every one of the South African States without exception; and under such Government the son of toil from this country may live and prosper, in amity with his fellow-subjects of every race; and in such Government all may have their due share, as subjects of the British Crown.

There was a time, so historians tell us, when remote Aryan ancestors of our own swarmed forth from Central Asia, some towards India, others towards Europe, north and south, to occupy the waste places of the earth, and to become in the course of long ages the parents of great and civilised nations. A swarming of the same kind set in, generations ago, from our own land, and has gone on increasing till America and Australia recognise Northern Europe as the parent of populous and growing nations which had no existence when the Cape of Storms was first doubled. South Africa is later in the field as a home for emigrants, but with capabilities to receive the superabundant myriads of Europe for many generations to come.

The native races, which have so long been regarded as insuperable obstacles to the progress of the country, will, I feel assured, at no distant period, be acknowledged as valuable elements in South African nationalities; for, in South Africa, I believe, the Government is ever anxious to act in accordance with the great truth which Englishmen have never been slow to recognise—that our duty with regard to races, inferior to our own in civilisation and power, is to do to them as we would have our Government do to us—to rule and protect them; to teach, to guide, and elevate them; and not to enslave or exterminate them.

APPENDIX A.

Meteorology.

The best account of any South African climate I have seen will be found in a full and comparatively late, as well as most interesting, chapter on the Natal climate, at pp. 59 and 105 of "Brook's Natal," edited by Dr. Mann, and in the chapter on climate in "Mann's Colony of Natal," pp. 47 and 69. It is much to be desired that similar papers were procurable, giving a scientific account of the climate of the other natural divisions of South Africa.

Much information on the climate and meteorology of South Africa will be found in Silver's "South Africa," 3rd edition, pp. 195 and 215 to 357 (Basutoland); for Natal, pp. 411 and 416; for Orange Free State and Bloemfontein, p. 457; also in the Cape Directory for 1880, p. 51 and p. 444 (on Natal), and p. 474 (on Transvaal); also in the "Emigrant's Guide," p. 79.*

The paper referred to in the following extract from the *Colonies and India* for December 11th, 1880, will probably be found to contain much that is needed in drawing up a good sketch of the climate of the Cape Colony:—

"The Rainfall in South Africa.—At the opening meeting of the present session of the Meteorological Society, held on the 17th ult., at the Institution of Civil

* But there are so many variations in different provinces as regards all that relates to climate and meteorology that no general sketch can do justice to the subjects.

Abstract of Weather Charts from December, 1876, to December, 1877.—Grahamstown, South Africa. Height above the Sea Level about 1,790 feet.

Month.	Thermometer. Average. Maximum.	Average. Minimum.	Greatest. Maximum	Greatest. Minimum.	Least. Maximum.	Least. Minimum.	No. of days upon which the maximum registered 90° and upwards.	80° and upwards.	Greatest observed heat in the sun.	Barometer. Highest.	Lowest.	Average.	Rainfall.	Remarks.
1876. December	74·7	58·0	87	62	63	43	none	12	117°	28·17	27·63	27·90		The readings of the thermometer give the registered maximum and minimum in the shade, the site being on a shady wall of a house, and under a verandah. These, and the readings of the barometer, were taken at 9 a.m. The observations of the greatest heat in the sun were usually taken between 1 and 2 p.m. from an ordinary thermometer mounted on box-wood, and hung on a dark painted pale of a garden railing facing north.
1877. January.........	79·3	60·0	101	71	63	51	4	17	134	28·20	27·80	28·00		
February	79·1	59·6	89	66	63	52	none	14	120	28·10	27·70	27·20		
March	79·3	61·9	90	71	65	55	2	15	114	28·30	27·65	27·97		
April	73·7	55·6	87	65	61	43	none	9	118	28·30	27·60	27·95		
May	65·0	49·0	78	54	54	42	none	none	110	28·20	27·60	27·90		
June	61·8	48·9	72	61	51	42	none	none	112	28·35	27·75	28·05		
July*	65·2	51·4	82	57	56	41	none	1	no record	28·50	27·95	28·22		
August	67·7	52·3	80	63	60	41	none	1	108	21·62	28·10	28·36	0·805	
September ...	69·2	47·4	92	60	56	40	2	4	114	28·68	27·78	28·23	1·231	
October	75·6	54·0	97	71	61	44	3	9	105	28·46	27·72	28·08	3·059	
November......	73·8	57·4	88	66	58	48	none	9	110	28·48	27·76	28·12	1·213	
December	81·3	60·1	99	68	64	51	6	18	119	28·40	27·70	28·05	0·492	

Notes.—* On the 6th, 7th, and 8th of July, there were no readings. No observation of the maximum and minimum thermometer between the 1st and 8th September (inclusive). Observations during September, October, November, and December were taken at Oatlands, which is about 1,850 feet above the sea level.

ABSTRACT OF WEATHER CHARTS FROM JANUARY TO DECEMBER, 1878.—GRAHAMSTOWN, SOUTH AFRICA. HEIGHT ABOVE THE SEA LEVEL ABOUT 1,790 FEET.

Month.	Thermometer in Shade.								Barometer. In Inches.			Rainfall. In Inches.
	Average.		Greatest.		Least.		No. of days on which the heat in the shade exceeded.					
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	90°	80°	Highest.	Lowest.	Average.	
January	82·6	61·6	105	69	70	54	14	23	28·36	27·93	28·14	0·43
February	77·2	60·3	91	66	63	54	2	12	28·48	27·86	28·17	2·44
March	75·4	58·0	95	69	55	45	1	8	28·43	27·95	28·69	2·55
April	75·2	55·2	90	63	63	42	1	6	28·59	28·12	28·35	1·44
May	68·0	49·0	82	61	57	39	none	3	28·56	27·99	28·28	1·02
June	63·7	45·2	73	51	47	37	none	none	28·67	27·98	28·33	1·47
July	62·6	43·6	78	58	52	36	none	none	28·57	27·96	28·26	1·01
August	60·8	42·2	80	50	47	32	none	1	28·73	28·16	28·44	1·99
September	68·7	49·2	91	59	50	35	1	4	28·60	28·10	28·35	2·76
October	74·8	50·4	87	58	61	43	none	9	28·50	27·61	28·05	0·58
November	72·9	58·0	105	63	62	47	4	13	28·47	27·92	28·40	2·72
December	77·2	56·0	107	68	64	47	6	16	28·40	27·85	28·13	1·81
												20·22

Engineers—Mr. G. J. Symons, F.R.S., president, in the chair—a paper was read by Mr. John G. Gamble, F.M.S., on "The Rainfall in South Africa." The author gives the monthly totals of rainfall from 103 stations for the thirteen months, December, 1878, to December, 1879, and also the monthly means from all stations in South Africa from which a record of five years or upwards could be obtained. It is shown that the Cape Peninsula, the South-West, and the West Coast have winter rains with a dry summer, characteristics of what is called the sub-tropical region, the rains coming with the north wind or anti-trade; while Natal, Aliwal North, and, in a less degree, Queenstown, have the tropical features of a wet summer and a dry winter. On the South Coast the rainfall appears to be more equally distributed throughout the year, though there seems to be an October maximum at Port Elizabeth and Uitenhage. In the Central and Northern Karoo the maximum of the very scanty rainfall occurs in February and March. These rains generally fall in thunderstorms, each storm seems to come from a westerly direction; but it is a more or less well ascertained fact that these rains do not fall up country until the south-easters have set it on the south and south-west coasts. In the south-east of the colony the transition towards tropical features may be noticed, both Grahamstown and King Williamstown showing a winter minimum in June."

Writing from 2, Garville-avenue, Rathgar, Dublin, December 15th, 1880. Mr. Charles G. Napier, who paid much attention to the meteorology of Grahamstown, says:—

"I send you enclosed the abstract of the weather charts for Grahamstown, 1878; you will see on comparison that they do not very much differ from those for 1877. I have also a slip out from one of the Grahamstown papers, by which it appears there fell there in 1875 21·60 inches of rain, and in 1876, 26·81 inches of rain.

"P.S.—The weather charts for 1878 were kept by Mr. Felix Cornual, formerly my clerk. I think he is still in Grahamstown, and has more information on the subject, as also have I. They kept, and I believe still keep, weather charts in the Albany Hospital, Grahamstown. Mr. John E. Davis, the superintendent, used to keep them."

APPENDIX B.

PUBLIC INCOME AND EXPENDITURE.

As regards the Cape Colony and Natal, it is difficult to condense the abundant information contained in Blue-books better than is done in the Directories for each colony, referred to in the lecture.

The following information regarding the Transvaal has not, I believe, as yet, been published in this country:—

TRANSVAAL FINANCES.

The annexed extracts from the Transvaal Government *Gazette*, of the 6th December, give the latest information regarding the financial position of that territory, as contained in the financial statement for 1880-1, laid before the House of Assembly, Pretoria, on the 30th November, 1880, by Mr. C. E. Stafford Steele, Financial Commissioner and Acting Colonial Secretary. It will be seen that from £70,000, which was considered a high estimate, after the annexation, the revenue has risen to £160,000, chiefly owing to the better realisation of the old taxes. No new taxes have been imposed. Some objectionable imposts, such as the war tax, have been remitted, and something has been done to reduce debt.

EXTRACTS.

"The revenue estimated for 1880 was £159,658, and the expenditure £153,751, leaving an anticipated surplus of £5,907. The amounts for next year are £172,300 and £164,234 respectively, which would give a surplus of £8,066.

"Turning to the statement for revenue it will be found that the total for the year 1879 was but £93,408, whereas during only three quarters of the current year £133,394 have been received into the Treasury against the twelve months' estimate of £159,658. The expenditure statement shows that £108,574 have been spent up to the end of September against the year's sanctioned expenditure of £153,751.

"Taking the income and disbursements of the nine months ending September, as compared with three quarters of the sums provided for on the estimates, an increase of revenue will be found amounting to £13,651 and a decrease of expenditure of £6,740.

"Whether the results on the expiration of the remaining quarter of the year will prove proportionately as

favourable as the foregoing is a question which, in a measure, depends on the outcome of the visit of the Honourable the Secretary for Native Affairs to the districts of Waterberg and Zoutpansberg. The collection of the native hut tax was undertaken at a late date, and a large amount would seem to be still due from the natives in those portions of the Province specified. Should, however, the collections this year fall short of the sum estimated, I have every hope that our finances will, nevertheless, be found to have attained a fair equilibrium. The forecasts under other heads have proved to have been so moderate, that unless any extraordinary liabilities be incurred during the remaining portion of the year, I think we may be fairly assured of such a result.

"Political questions have, no doubt, in a measure affected the revenue. The whole of one district (Bloemhof) and portions of two others (Marico and Potchefstroom) fall within what is known as the Keate Award Line, and pending the final settlement of the matters at issue, the payment of taxes has not been enforced within those arrears. It is not surprising, therefore, that the Govenment dues, paid in the Bloemhof district, do not exceed £260.

"Then, again, the Boer agitators are responsible for some portion of the revenue not finding its way into the Treasury. Besides those who refrain from paying, in order to mark their hostility to the Government, there are many who would willingly pay, but do not merely from a lack of moral courage. These latter fear to come forward, but yield to their terror of the opinions of the more violent members of their community.

"I have still to show why a larger sum is anticipated for collection under quitrent in 1881 than that estimated for in 1880, more especially as it has just been proved that only a little more than half the estimated receipts for 1880 were collected from this source. In respect of this I would state that the returns of the Landdrosts were set aside as not being sufficiently trustworthy, and that, in framing this estimate, the conclusions arrived at have been based on statistics regarding landed properties obtained from the office of the Registrar of Deeds. The information so acquired can, I think, be accepted as reliable.

"A few remarks are necessary regarding the railway tax. The receipts during 1880 from this source (both current and arrear) up to the end of September came to £18,500. The amount collected during the whole of 1879 was but £9,496.

"In the early part of this year it was ascertained that the present rate was unnecessarily high for the attainment of the special object for which this tax was imposed. Its reduction was, therefore, determined upon, and a Bill providing for this has recently passed through its third reading in this House. It may be as well to point out that Government cannot afford to remit taxation, and the reduction would not have been made had Government felt itself justified in applying the proceeds of this tax to other purposes than those for which it was created. The charges against the proceeds of the railway tax have hitherto been swollen by survey expenses, payment of claims on material lying in Holland, law charges, and by other miscellaneous items of expenditure connected with Mr. Burgers' scheme, which are not likely to be incurred again. There is every reason to believe, therefore, that, for the future, it will be possible to devote the receipts from this tax solely to the payment of the interest on the debt, and to the liquidation of the principal. For this purpose £7,000 are required annually, and this represents the sum for collection placed on the estimates for the coming year. I should mention that the new law will provide for a possible income of about £8,000. There are, moreover, large outstanding balances still due under this head of revenue, as also the value of material sold, to credit to the railway account.

"With regard to the native hut tax, the amount to be derived from this branch of the revenue continues to be a subject of speculation. The collections were not undertaken much before the month of May, and by the end of September, £13,225 had been paid into the Treasury, a further sum of £7,000 being in transit at the time. The Hon. the Secretary for Native Affairs is personally superintending the working of the law. The three most populous districts have yet to contribute their quota to the revenue; it is possible, therefore, that the anticipations in respect of this tax may yet be realised before the end of the year. It has to be borne in mind, however, that the officials entrusted with the duty of levying this tax are new to the work, and, moreover, that their knowledge of the country has been necessarily limited, owing to the native disturbances, now happily at an end. This ignorance of the country is no doubt taken advantage of, and many evade paying who will not so easily escape next year, when the native commissioners and others become better acquainted with the nature and scope of their duties. Thus, in the absence of any apprehension as to the soundness of the estimate framed for the current year, viz., £35,000, it has been considered safe to place an additional £5,000 to this sum for the estimates of 1881.

"Duties generally are expected to yield a much larger revenue to that hitherto obtained. In 1879, the duties (inclusive of import) came to £54,652. For 1880, they were estimated at £53,103, but at the end of last quarter they had already reached the sum of £57,922.

The amount placed on the estimates for next year is £71,670.

"The principal heads under which such a large increase is anticipated are import duty, transfer dues, licenses and revenue stamps.

"On referring to the revenue statements placed on the table, it will be seen that from import duty an increase is expected of £3,850, as compared with the sum estimated for 1880. In 1879, £19,252 were received; during nine months of this year a sum of £17,791 was collected, and for 1881, £22,120 have been placed on the estimates. The unsatisfactory working, and also the somewhat unfair incidence of this tax has not been lost sight of. It is hoped that the approaching settlement of the Keate Award question will enable Government to adopt measures for the prevention and detection of what may be termed the smuggling which, there is ample evidence to prove, is carried on in the south-western districts. The steps to be taken for the better application of the law in other districts is a matter which is at the present moment under the consideration of Government. Fewer evasions of the law are expected, and it is anticipated that the continued prosperity of the country will fully justify this forcast made of the receipts from 'customs.'

"Coming now to 'Duties other than Import,' the chief items calling for remark are transfer dues, licenses and revenue stamps.

"First, to take transfer dues:—

"The estimated amount for the current year is £10,000; the receipts up to the end of September exceeded, however, that sum by £2,280. For 1881, £16,000 have been placed on the estimates. The expectations in respect of this increase are based on more extensive sales of land being anticipated, and on the coming into operation of the new law—XI, 1880. Under the provisions of this law, it is competent for the Receiver of Transfer Duty to cause a valuation of property to be made when the price under which it is alleged to change hands appears inadequate.

"*Licenses.*—In 1879, £8,786 were received under this head. For the current year, £9,125 were estimated; the receipts are about £1,400 in excess of this already. For 1881, £12,000 have been placed on the estimates, and there is every reason to believe this sum will be realised.

"*Revenue Stamps.*—The extension of the principle of

collecting certain items of revenue by means of stamps has been attended by beneficial results. In 1879, a sum of £13,457 was collected in this form; during nine months of this year £13,747 were collected. The somewhat large increase for 1881 is anticipated partly on the grounds stated in connection with transfer dues, and partly in consequence of measures having been introduced in this House providing for fees being levied in certain cases, notably under the Insolvency Law.

"Under 'other receipts' are comprised certain items which amounted, in 1879, to £7,501. During the three-quarters of the current year they amounted to £10,834. A sum of £9,250 has been estimated for 1881. The excess, during 1880, as compared with the figures for 1879, is due partly to increase sales of Government property, and partly to the fact that the receipts of the Telegraph Department are included under this main head. The line having been opened only during the latter part of last year, the receipts for 1880 are naturally considerably greater than those for 1879. Proportionately, however, the receipts do not compare favourably, and there would appear to be a falling off in the work which is not confined to a reduction in the number of Government messages. The revenue from this department, for 1881, has, consequently, been estimated at a sum representing nearly the receipts of the current year.

"The total revenue to be derived under all sources, during 1881, has thus been shown at £172,300, from which an estimated expenditure of £164,234 1s. 6d. has to be met.

"On referring to the statement, it will be found that the disbursements for 1881 are expected to exceed those of the year now drawing to a close by £10,482. According to the analysis of the expenditure given in the statement, there is an excess in the cost of establishments of £14,436. This large excess is, however, not real, as I will proceed to explain. It will be noticed that the classification of the expenditure for 1881 differs materially from that adopted in last year's printed estimates. This modification in the form of the estimates has been followed in accordance with the wishes of the Right Honourable the Secretary of State, conveyed by his despatch No. 33 of June last. In the carrying out of these changes, large amounts, formerly appearing under the separate heads of aborigines, colonial defence, forests, &c., are now embodied under 'Establishments.' The charges appearing under those heads in this year's estimates represent solely expenditure on services exclusive of establishments. A no less sum than £10,800 of the apparent increase is simply due to this alteration in the mode of classification. To the revision of establishments, and of the rates of salary, an increase accrues on last year's estimates of £3,600. This sum is arrived at after deducting the saving effected in certain departments consequent on such revision.

"This scheme, to which the Secretary of State has notified his approval, allows of a permanent increase in salary to ten officers of the Government, and it further provides for additions on the incremental principle to the salaries of twenty-two other officers.

"The sums expended in 1879 on pensions and grants amounted to £1,673 11s. 11d.; for the current year, an expenditure under this head of £1,430 was estimated for; the amount entered for 1881, is £2,150, of which £1,650 only is foreseen. The following are the names of recipients of pensions, now appearing on the estimates for the first time:—Sir Theophilus Shepstone (late Administrator); P. J. van Staden (late Landdrost); Mrs. Hamilton (widow of Captain Hamilton); and Captain Beeton.

"*Colonial Defence.*—The apparent decrease in expenditure under this head, as compared with the actuals for the current year, is not real. The charges on account of colonial defence during the coming year will be far in excess of those which the Province has hitherto been called upon to meet. Under the head of 'Establishments,' it will be found that an outlay of £6,805 has been provided, on account of a force consisting of (73) seventy-three mounted men (officers included) and of (186) one hundred and eighty-six foot police. The amount shown under 'Colonial Defence' in the statement represents the cost of ration, equipment, &c., and the value of the contribution payable to the Imperial Government for the maintenance of the mounted infantry. The scheme for which provision was made on the estimates for 1880 was purely a tentative one.

"*Public Works.*—Under this head a sum of £9,810 appears on the estimates for 1880, of which only about one-half was expended up to September. I should state, however, that over £7,000 has been spent to date, and that the Surveyor-General reports work on hand on which a further outlay is involved of £2,500. In connection with these works, material of the value of about £500 has been used which does not show in the accounts. This sum represents the value of material prepared for building purposes by convicts.

"As it is a somewhat common complaint that, although the public are called upon to pay road-tax, the roads are rarely repaired, I would mention that the receipts from road-tax (current and arrear) during the three quarters of this year were but £627, whereas the expenditure on roads and bridges is expected to reach the sum of £1,400, of which £800 have already been spent.

"The necessity for public works on a large scale being undertaken is fully recognised; the current revenue could not, however, stand the additional strain which would be brought to bear on it by any extraordinary works being taken in hand. The reduction of the expenditure below the limit exhibited in these estimates does not seem feasible; special measures will therefore have to be taken to admit of works on a large scale being carried out. Whether it would be desirable to add to the burdens of the Province by borrowing capital for the construction of unproductive works is a matter which, I think, is open to question. It is certainly true that the annual rent for Government buildings in Pretoria alone represents a capital of £15,500, raised at 6 per cent. But I am afraid we should not obtain the accommodation we now have by expending that sum on new buildings.

"As regards the present debt of the Province, and judging by the charges annually payable on it, we find that in 1880 (1-7th) one-seventh of the revenue was devoted to meet the charges payable on account of interest, and in part liquidation of the principal. For 1881, the charge will be about (2-15ths) two-fifteenths of the estimated revenue, or about 2s. 7d. in the £; the fact must, however, be carefully borne in mind that the present debt is not a perpetual charge on the revenue, for, as will be seen from the statement which has been placed on the table, the principal is gradually becoming reduced. As an instance I would point out that of the two funded debts one (£63,000) should be extinct in 1893, and the other (£93,833) in 1902.

"Lest in making these remarks I be misunderstood, I would at once state that there is ample evidence of a marked financial improvement having set in, and I think we may depend upon even greater progress in the future. In support of this I would mention that whereas our overdraft, both at the Crown agents and at the Standard Bank, amounted on the 1st January to £163,496; at the present moment it is only £140,900. In reference to this improvement I notice in the leader of this morning's *Argus*, the following statement:—

"'But when it is considered that the process of squeezing has been very freely resorted to, the better balance-sheet shown by this Government can scarcely be regarded as representing the free and willing payment of taxes. In the majority of cases the debtors at all events wait until the demand has been made, and not a few refuse to pay until actually summoned before the Law Courts.'

"With regard to this, I am happy to be in a position to show that our balances have not been materially affected by the action of the Courts. In September last I requested the Landdrosts to report what portion of the revenue received by them had been paid after the issue of notices, how much after summonses, and how much through subsequent legal proceedings having been taken. From their replies I find that a no less sum than £18,200 was paid on intimation of the amount due being received by the parties, £1,500 on summonses being issued, and £500 only on subsequent action of the Lower Courts.

"From this it may be inferred the 'process of squeezing has been applied, perhaps, more in revenue officials than to revenue defaulters. Had the revenue officers been passed to do their duty, or had they been accorded greater facilities in the performance of it, in years gone by, it would not have fallen to the lot of this Government to collect the arrear taxes due to the late Republic. That there are many who adopt the *rôle* mentioned in the *Argus* is unfortunately a fact, but the present balances, as I have already stated, have not been materially affected by the attitude they have assumed, the conclusion to be drawn being that but for such action the improvement in the balances would have been even still more marked."

TRANSVAAL FINANCE.

COMPARATIVE STATEMENT PREPARED IN CONNECTION WITH THE FINANCIAL STATEMENT FOR 1880-81.

REVENUE.

HEADS OF SERVICE.	Actuals during whole of 1880.			Actuals for Three Quarters of 1880.			Estimates for the Full Year 1880.			Estimates for 1881.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Taxes	20,302	13	7	39,275	19	3	48,972	0	0	41,870	0	0
,, Native	596	10	0	13,225	10	0	35,000	0	0	40,000	0	0
Import Duties	19,252	19	8	17,791	18	9	18,270	0	0	22,120	0	0
Duties other than Import	35,399	14	0	40,130	4	11	34,833	0	0	49,550	0	0
Postage	5,732	14	4	5,094	15	10	6,000	0	0	7,000	0	0
Other Receipts	7,501	19	0	10,834	1	7	6,463	0	0	9,252	0	0
Special Receipts	4,622	5	11	7,041	16	6	10,120	0	0	2,508	0	0
Total	93,408	16	6	133,394	6	10	*159,658	0	0	172,300	0	0

EXPENDITURE.

HEADS OF SERVICE.	Actuals during whole of 1879.			Actuals for Three Quarters of 1879.			Estimates for the Full Year 1880.			Estimates for 1881.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Establishments	36,499	0	9	28,394	2	4	49,299	10	0	63,735	10	0
Pensions and Grants	1,673	11	11	1,066	8	6	1,430	0	0	2,150	0	0
Colonial Defence	2,272	4	6	11,961	6	8	16,196	5	4	11,862	9	6
Public works	5,009	19	5	4,116	4	2	9,810	0	0	8,318	0	0
Conveyance of Mails	13,395	6	5	7,695	2	11	12,200	0	0	11,461	10	0
Aborigines	3,518	16	11	5,223	19	7	5,298	0	0	3,595	0	0
Judicial	4,654	19	5	5,005	15	1	7,290	0	0	9,078	0	0
Other Payments	31,342	9	5	27,751	8	3	35,778	2	0	39,010	12	0
Special Payments	19,388	5	6	4,760	5	5	6,050	0	0	5,700	0	0
Repayment of Loans	17,059	6	2	7,159	9	4	7,400	0	0	7,333	0	0
Drawbacks and Refunds	817	17	9	1,950	12	1	....			2,000	0	0
Telegraph Construction	41,961	19	7	3,489	10	1	3,000	0	0	....		
Total	177,595	17	9	108,574	4	5	153,751	17	4	164,234	1	6

* To date our receipts have reached the sum of £171,300.

APPENDIX C.

TRADE OF CAPE, NATAL, AND ORANGE FREE STATE.

The following brief statement of facts will illustrate the growth of the Cape Colony during the past sixty years:—

GROWTH OF CAPE COLONY.

1820.—Area, 128,000 square miles; population—white, 48,000; Hottentots, 29,000; slaves or apprentices, 33,000; total population, 110,000.

1821.—Imports, 454,166; exports, £150,900; including wine, £82,170; public revenue, £109,000; public expenditure, £93,000.

1830.—Total population of eastern districts only, 30,000.

1830 to 1834.—Imports (in eastern districts only), £134,119; exports, £207,282.

1845 to 1849.—Imports (in eastern districts only), £1,356,000; exports, £1,017,391.

1850.—Total population of eastern districts only, 170,000.

1856.—Imports, £1,588,000; exports, £1,327,000 (exclusive of diamonds); public revenue, £348,000.

1865.—Population, 496,300.

1866.—Exports, £2,590,000 (exclusive of diamonds); public revenue, £732,000.

1875.—Population, 720,900, composed as follows:—Europeans, 236,783; Kaffirs and Bushmen, 314,133; Hottentots, 98,561; mixed races, 87,184; Fingoes, 73,506; Malays, 10,817; total, 720,984.

1876.—Exports, £4,499,000 (exclusive of diamonds); public revenue, £1,864,000.

PRINCIPAL IMPORTS AT DURBAN FROM OFFICIAL RETURNS.—COLONIAL GOVERNMENT VALUATIONS.

Description.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	Nine Months of 1880.
	£	£	£	£	£	£	£	£	£	£	£	£
1. Cotton Manufactures	46,626	51,852	61,977	102,377	86,824	85,246	98,275	58,548	56,910	103,035	131,245	82,140
2. Do. Blankets and Sheets	17,561	13,968	7,561	20,042	39,135	24,614	22,592	17,370	12,857	27,523	28,579	23,038
3. Linen Manufactures	3,710	3,173	7,949	20,183	10,476	9,128	12,090	8,920	4,299	12,793	25,910	10,761
4. Woollen Manufactures	11,415	12,048	12,403	22,447	23,872	15,520	19,961	9,632	13,418	16,368	19,972	17,305
5. Woollen Blankets	14,641	12,169	6,329	18,842	39,163	33,785	27,635	38,481	16,682	37,111	61,902	92,408
6. Leather Manufactures	14,632	15,603	21,708	33,577	40,188	51,057	70,854	55,315	38,106	67,136	99,038	85,242
7. Apparel, &c.	25,405	36,147	36,620	64,656	78,547	93,915	109,613	94,585	83,078	154,854	240,381	169,823
8. Haberdashery	36,494	42,348	50,361	77,546	96,286	101,381	134,040	73,935	80,604	136,546	186,025	150,350
9. Beads	..	..	..	..	..	..	..	..	..	5,026	2,995	5,296
10. Stationery	5,184	5,289	7,368	8,159	10,376	10,422	14,058	13,668	14,164	22,079	23,186	22,046
11. Guns and Pistols	5,604	7,511	8,703	20,156	38,430	28,316	24,121	10,684	4,825	8,775	7,207	3,549
12. Gunpowder	3,049	7,911	1,634	4,563	10,335	15,140	847	1,321	3,875	3,614	3,418	1,281
13. Saddlery	1,970	3,710	7,416	14,776	27,150	25,220	25,567	15,073	14,105	29,116	52,489	44,205
14. Cabinet and Upholstery Ware	3,663	4,267	2,597	8,866	21,797	16,446	19,534	17,322	20,583	26,473	29,785	31,789
15. Agricultural Implements	2,323	2,191	3,516	4,224	14,523	11,716	4,959	9,069	13,517	13,503	11,320	18,142
16. Machinery	10,727	15,204	13,762	18,363	32,410	25,124	31,335	35,671	34,800	26,045	21,665	26,304
17. Iron of all kinds	8,477	10,216	12,270	26,876	18,257	30,410	56,439	38,622	34,936	60,882	40,370	42,963
18. Ironmongery, Cutlery, &c.	14,862	21,118	27,564	48,557	71,551	85,893	86,062	30,225	54,625	76,685	97,746	54,848
19. Ale and Beer	11,464	8,957	11,650	17,595	19,961	20,514	23,868	26,208	28,905	57,736	60,298	70,750
20. Spirits	6,460	7,277	8,411	19,073	15,722	29,008	27,401	24,064	38,261	45,352	72,472	80,526
21. Wine	4,946	5,753	7,085	14,587	14,996	17,356	16,722	11,735	18,222	21,335	40,779	31,965
22. Coffee	9,991	11,817	2,597	3,666	3,167	9,662	34,118	22,258	42,284	84,976	36,739	32,874
23. Tea	5,820	5,266	5,536	9,791	8,261	7,203	10,474	10,863	9,315	24,288	18,612	5,490
24. Sugar, Raw and Refined	751	828	737	825	1,123	1,464	1,138	883	759	1,353	3,601	1,596
25. Oilmen's Stores	3,968	3,692	5,931	14,477	8,101	17,909	18,142	12,746	19,684	28,491	52,540	25,657
26. Tobacco and Cigars	1,532	1,432	2,082	4,438	5,604	5,326	6,608	6,813	6,136	9,045	25,244	13,124
27. Flour and Meal	15,414	12,364	18,816	17,053	23,027	38,099	33,243	30,969	53,164	96,191	85,176	42,145
28. Grain of all kinds	2,574	427	1,728	3,256	4,431	4,508	13,252	4,208	5,236	8,035	33,659	1,953
29. Rice	9,509	7,747	7,285	19,871	10,781	23,376	20,739	18,368	24,998	38,183	58,050	12,298
30. Others	..	..	..	..	..	..	..	..	..	..	605,923*	450,361
Total Value of ALL Articles Imported	380,331	429,527	472,444	825,252	1,011,465	1,121,948	1,268,838	1,022,896	1,167,402	1,719,562	2,176,356	1,650,232
ABSTRACT. IMPORTS.												
Clothing, Nos. 1 to 9	170,284	187,308	204,908	359,670	414,491	414,646	495,060	356,786	305,954	555,366	793,082	631,070
Food, Nos. 19 to 28	72,429	65,560	71,858	124,632	115,174	174,425	205,755	169,115	246,864	414,985	487,170	320,378
Customs Import Duties Government Revenue	39,702	45,571	46,726	81,913	96,003	109,724	114,769	97,108	106,286	162,947	228,510	183,215

* 41,364 Railway materials included.

Principal Exports by Sea from Official Returns.—Colonial Government (Customs) Valuations.

(From Dr. Mann.—Prepared by Hon. F. Drummond.)

Description.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1st Jan. to 30th Sept., 9 months of 1880.
1.—Arrowroot	£4,684	£4,696	£3,858	£5,647	£1,435	£2,226	£2,327	£3,806	£4,559	£6,841	£3,607	£1,489
2.—Grain	2,328	1,219	5,022	853	845	1,243	716	2,185	2,037	14,386	321	4,689
3.—Butter	8,403	7,298	4,719	5,178	4,509	963	2,019	689	821	1,724	...	...
4.—Hides	20,788	23,867	32,663	41,124	50,117	82,473	100,788	41,322	34,821	31,783	34,873	37,389
5.—Skins	24,915	45,275	63,975	91,469	85,809	70,688	45,942	13,252	7,919	5,406	2,509	2,339
6.—Ivory	10,449	12,051	12,140	9,022	17,168	8,580	8,289	11,006	15,014	12,044	8,678	5,025
7.—Ostrich Feathers	4,757	6,364	6,910	9,745	5,940	3,138	4,057	2,572	1,354	4,499	9,410	6,643
8.—Salt Meat, Bacon, and Hams	9,159	5,715	3,076	1,180	1,078	100	...	...	...	...	...	...
9.—Fruit	...	...	...	...	...	...	...	...	279	324	300	305
10.—Coffee	5,011	7,512	5,675	8,516	3,507	3,348	1,586	778	112	160	23	16
11.—Rum	1,364	2,051	2,182	1,227	736	1,391	4,259	3,059	2,243	644	23	500
12.—Cotton	2,301	3,479	5,763	5,400	4,379	1,165	203	89	...	...	...	...
13.—Cayenne Pepper	...	...	...	...	...	...	...	...	983	1,417	445	368
14.—Sugar	145,711	111,023	180,496	153,855	161,840	159,079	169,815	135,259	185,130	141,407	56,956	140,895
[Weight	7,477 tons	5,328 tons	8,741 tons	7,096 tons	7,065 tons	6,833 tons	7,775 tons	7,577 tons	9,194 tons	7,516 tons	3,010 tons	7,309 tons
15.—Wool	105,544	120,778	172,806	254,495	253,170	338,936	389,257	366,219	383,019	429,657	415,890	443,821
[Weight	3,350,437 lbs	3,612,501 lbs	5,763,939 lbs	5,654,416 lbs	6,309,573 lbs	7,888,794 lbs	8,108,397 lbs	8,548,611 lbs	10,012,356 lbs	12,077,966 lbs	12,029,216 lbs	12,840,629 lbs
16.—Angora Hair	...	...	...	...	...	...	...	1,468	4,519	6,487	4,897	9,743
Total Colonial	...	...	...	...	...	...	...	...	...	...	...	654,458
Not Colonial	...	...	...	...	...	...	...	...	...	...	43,670	31,212
Total Exports (above and other articles)	363,262	382,979	562,109	622,797	651,028	769,988	835,643	657,390	689,817	694,192	583,711	685,670

Abstract of Natal Trade for Twenty Years, 1859 to 1878.

By Sea at Durban.	Ten Years, 1859—1868.	Five Years, 1869—1873.	Five Years, 1874—1878.	Ten Years, 1869—1878.	One Year, 1878.	1879.	Nine Months, 1880.
Imports	£3,777,604	£3,119,019	£6,300,646	£9,419,665	£1,719,562	£2,176,356	£1,650,232
Exports	1,786,656	2,582,175	3,647,076	6,229,251	694,192	583,711	685,670
Imports and Exports	£5,564,260	£5,701,194	£9,947,722	£15,648,916	£2,413,754	£2,760,067	£2,335,902
Customs Duties	£375,609	£309,915	£701,789	£1,011,704	£162,947	£228,510	£183,215
Clothing, Imports $\frac{1}{8}$	£1,279,573	£1,336,681	£2,127,812	£3,464,493	£555,366	£793,082	£631,070
Food, Imports $\frac{15}{28}$	£936,302	£449,653	£1,211,144	£1,660,797	£414,985	£487,170	£320,378
Sugar, Exports	£503,996	£757,925	£790,690	£1,543,615	£141,417	£56,956	£140,895
,, Weight	23,753 tons.	35,708 tons.	38,905 tons.	74,613 tons.	7,516 tons.	3,010 tons.	7,309 tons.
Wool, Exports	£544,154	£906,794	£1,908,088	£2,814,882	£429,657	£415,890	£443,821
,, Weight	12,935,648 lbs.	24,690,926 lbs.	46,636,124 lbs.	71,327,050 lbs.	12,077,966 lbs.	12,029,216 lbs.	12,840,629 lbs.
Sugar and Wool	£1,048,150	£1,659,719	£2,698,778	£4,358,497	£571,064	£472,846	£584,716
Actual Government Revenue	£1,008,780	£751,044	£1,414,939	£2,165,983	£369,384	£473,478	
,, ,, Expenditure	£1,071,296	£650,330	£1,494,252	£2,144,582	£387,067	£490,825	

1820.—Currency, depreciated paper; churches out of Cape Town, 3; education, much neglected; *Government Gazette*, and an advertising sheet, only periodicals publications.

1824.—Press statistics—7th January, Messrs J. Fairbairn and Thomas Pringle (*The Post*), published in Cape Town, the first number of the *South African Commercial Advertiser*; May 17th, publication interdicted by Lord Charles Somerset.

1827-8.—Royal Commission sent out in 1824, recommended in Report, dated 6th September, 1826; freedom of Press; establishment of Supreme Court, under Royal Charter of Justice; substitution of Civil Commissioners, Resident Magistrates, and Justices of the Peace, for Boards of Landdrost and Heunraden; abolition of "Pacht" (Government monopoly of sale of wines and spirits) of office of Vendu-Master (Government Auctioneer), and Burgher Senate.

1829 to 1839.—South African College founded in 1829. Sir J. Herschel arrived 16th January, 1834, and submitted an education scheme to Government in 1839. Dr. Innes, first Superintendent General of Education. 20th May, 1835, King William's Town founded. Abolition of slavery, proclaimed in 1834, came into effect at the end of four years' apprenticeship, in 1838. 1836—Six thousand Dutch colonists followed Field Cornet Piet Retief, when he "trekked" from the colony.

1840 to 1850.—Road-making commenced by Mr. John Montagu, Colonial Secretary. Public road Board, established 1844. Territory of Natal annexed to Cape of Good Hope, 31st March, 1844. 29th July, 1848, Battle of Boomplaats, declaration of British Sovereignty over Orange Free State, and consequent founding of Transvaal republic by defeated emigrant Boers.

1851 to 1861.—1853, 21st April—Orders in Council granting representative constitution. First Parliament, 1854. Orange Free State made independent, 1854. First sod of Wellington Railway turned by Sir George Grey, 31st March, 1859. Railway finished, 1863. First truckful of stone for Cape Town breakwater tilted by H.R.H. the Duke of Edinburgh, 17th September, 1860. First stone of docks laid by H.R.H., 25th August, 1867. First line of electric telegraph completed to Simon's Farm, 1860. Public library and museum founded by Sir George Grey.

1862 to 1879.—First diamond discovered, 1867. Responsible Government established, 1872. University of Cape of Good Hope incorporated, 1873. Griqualand West annexed, 1877-80. Submarine cable, 1880.

1865.—Education—Schools, 360; scholars, 30,335; State expenditure, £23,027; local expenditure, £19,396; area of holdings in Colony (morgen of two acres each), 20,464,000; area of land under cultivation (morgen), 217,692; wool produced, 18,905,000 lbs.; mohair, no return; live stock (woolled sheep), 8,370,000; draught cattle, 249,000; other cattle, 443,000.

1875.—Education—Schools, 641; scholars, 54,157; State expenditure, £38,753; local expenditure, £43,595; area of holding in Colony (in morgen—two acres), 39,947,000; area of land under cultivation (in morgen), 274,413; wool produced, 28,316,000 lbs.; mohair, 128,128 lbs.; live stock (woolled sheep), 9,986,000; draught cattle, 421,000; other cattle, 689,000.

1879.—Education—Schools, 843; scholars, 66,000. State expenditure, £70,000; local expenditure, £81,000'.

The following statistics of three districts in the Orange Free State, are taken from the *Cape Times*, of the 10th November last:—

"The *Friend of the Free State* gives the following statistics:—'The total population of the district of Bloemfontein, Winburg, and Cronstadt is, respectively, 13,274, 15,858, and 14,177—the first named district, however, possessing the largest number of white inhabitants. The number of woolled sheep in the said three districts is, respectively, 640,031, 582,390, and 478,160. The entire area of the district of Bloemfontein is 1,139,165 morgen, of which 1,894 are cultivated; Winburg, 1,337,340, of which 3,878 are cultivated; and Cronstadt, 1,522,300, of which 6,649 are cultivated. Cronstadt is consequently the largest district of the three, and Bloemfontein the smallest. Bloemfontein possessses the most horses and woollen sheep, Winburg the most horned cattle and big-tailed sheep, and Cronstadt eclipses the other two districts in the number of hides it annually produces.'"

APPENDIX D.

Diamond Cutting in Clerkenwell.

In connection with the industries that are materially affected by the discovery and importation of Cape diamonds, the recently established lapidary works of Messrs. W. Ford and Co., of Clerkenwell, deserve a notice. A full and detailed account of their establishment appeared lately in the "Watchmaker, Jeweller, and Silversmiths' Trade Journal."

About a century and a half back, London was the chief seat of the diamond-cutting business. Circumstances caused this industry to be removed to Amsterdam, and this city till very lately held the monopoly of this trade. To the untiring efforts of Mr. W. Ford is due the revival of this industry in England. About seven or eight years ago he, then a lapidary in Red Lion-street, first turned his attention to the cutting and polishing of diamonds. Great perseverance was necessary, because people naturally hesitated to entrust valuable crystals to the least chance of unskilled handling. This prejudice was, however, gradually overcome, as Mr. Ford's skill was well able to show that the diamond cutter's art was not in the sole possession of the Dutch. Although at first mostly dependent on Dutch workmen, they are now all superseded by Englishmen, to the great satisfaction of the firm. It is to be regretted that some of the diamond cutters emulate the jealousy of their Dutch brethren, and try to keep their experiences to themselves. Such is, however, the case; so that Mr. Ford was obliged to separate men and apprentices, and to take the latter under his own supervision. Already, in 1874, some of Mr. Ford's *employés* carried off several prizes offered by the Turners' Company for lapidaries' work. Mr. Vincent Albertoldi secured first prize for his remarkable fine shell and cross of carbuncle, and Mr. Henry Giles Spencer the second, for carved onyx shell, bow and flower of great beauty. Their exhibits were bought by Mr. Hunt and Professor Tennant, two of the judges for the lapidary work—a mark gratifying alike to the artists and their employer. In class D (diamonds), Mr. John Parsons and Mr. Alex. Watts, also employed in this factory, took second and third prizes respectively. In 1876, Mr. Charles Errington, Mr. George Brown, and Mr. Thomas Jones were again successful competitors for prizes offered by the same company, all *employés* of this establishment.

Extract from the "South African" for Nov. 1880.*

The Diamond Fields of Griqualand West.—By R. W. Murray.

The South African Diamond Fields are one of the greatest, if not the greatest, wonders of modern times. The discovery of diamonds on the banks of the Vaal River, in 1868 and 1869, attracted thousands of colonists to that part of Griqualand West, and to the establishment in 1870 of the Hebron, Pniel, and Barkly Diggings, and afterwards to such other river diggings as Waldek's Plant, Cawood's Hope, &c., &c. Up to nearly the end of 1870 it had been concluded that diamond deposits were only to be looked for on the banks of that

* A paper by Mr. T. W. Tobin, "Notes from a Diamond Tour through South Africa," is published in the *Journal*, Vol. xx., p. 351.

river, but before 1870 had closed, it became known that diamonds had been found at Du Toits' Pan without washing out the diamondiferous soil, which was, during the early time of the river diggings, a most laborious operation. The river diggings was then almost abandoned, and diamond-searching was carried on for a long time at Du Toits' Pan on the dry-sorting system. During the year 1871, it was ascertained that there were diamonds in the Kopjes of Old de Beers and Bultfontein, and in July of that year the Colesberg Kopje (now the Kimberley Mine) was rushed, and the whole of the four before-mentioned diggings were for a long time worked on the dry sorting system, and the *débris* thrown together in heaps outside the diggings and abandoned. In 1873, however, the diggers found that the abandoned *débris* contained almost as many diamonds as they had taken out of the diamondiferous soil whilst it was in their hands, and that it would be ruinous to continue the dry-sorting system, as one-half of the diamonds would be lost to them, unless the soil, when taken out of the claims was thoroughly saturated and washed out with water, as they had been accustomed to wash it out when digging on the river banks. When the Kimberley Mine and the Vooruitzigt estate, on which the Kimberly Mine is situated, were purchased from Messrs. Ebden and Co., the proprietors, by the Government, £10,000 was offered for the abandoned *débris* surrounding that mine alone, which offer was refused.

The diggers having ascertained that water was the great essential to successful diamond-searching, and the character of working claims having changed, at least six years since, from diamond-digging to mining for diamonds, new and more effective appliances than the cradles used at the river were invented, and wells were dug. It was also ascertained, when the light surface soil was passed, that the richer diamondiferous strata was of a rocky nature, and that this must be thoroughly saturated with water, and exposed to the sun, before it could be sufficiently crumbled for washing out in the rotary machine; and, from the time that strata has been the diamond-yielding material, the demand for water has been immense, and far greater than the supply.

In the last six years, at Kimberley, Old de Beers, Du Toits' Pan, and Bultfontein, diamond-mining has been a permanently settled industry, as is coal-mining in Newcastle, copper-mining in Cornwall, or tin-mining in Devon. It was estimated long since that there was invested in claims, plant, and steam machinery, in the beforementioned four mining centres, over twelve millions sterling (£12,000,000), and Messrs. Robey, Ransome, and Sims, and other engine and machine manufacturers, are sending out first-class engines and machinery by mail steamers, and are never without orders in course of execution. There are no investments so much sought after as those which the diamond-fields offer, and the value of claims has increased more during the last year than in any other year of the existence of the diamond-fields.

The claimholders consider that when the Kimberley Water Company shall have made the water supply sufficient and regular, their returns will be so much larger as to greatly add to the value of their claim properties, which they, since the last Act of the Griqualand West Legislature, hold on fixed property titles, instead of on monthly license as heretofore.

In no season does the present water supply approach the demand for mining operations and town consumption. The rainfalls are confined to but a few months of the year only, and, subject as the country is to periodical droughts (which, during the ten years of the diamond fields, have covered half the period of their existence), the wells dry up, and mining operations are occasionally brought to a standstill.

From the Vaal River only can a sufficient supply of water for miners and householders be obtained. Water must be had by the miners at whatever price is demanded by well proprietors, as the suspension of mining operations is utter ruin. The claimholders, by such suspension, would lose all their native labour, and when once the natives are thrown out of employ, they leave for their homes, many of which are from 1,000 to 1,200 miles distant. The costly establishments must be kept up, license money must be paid to Government, and rates to the mining boards, whether the claims are worked or not, and all this in addition to the loss on dormant capital invested, which is very great, seeing that many of the claims of 30 feet by 30 are of the value of from £5,000 to £10,000 each.

Water has for years never been obtainable for less than 2s. 6d. for about 100 gallons, and in times of drought it averages 5s.

Since the establishment of the mines, fine, large, permanently settled towns have grown round the mining centres, churches of all denominations, with accommodation equal to those in the older towns, have been built, and others are in course of building. The Customs' duties paid on imported articles of consumption in the fields has been estimated by the Secretary of State for the Colonies to be at least one-third of the whole amount received at the colonial ports; over one million and a-half is paid for land carriage from the port towns to the fields; the trade done in Kimberley, Du Toits' Pan, Old de Beers, and Bultfontein is larger and more brisk than in any towns of the same size in South Africa, and four banks have been established, and they do a very large and lucrative business.

During the last seven years the mines have afforded employment to 650,000 natives, at an average wage, in money and kind, of 22s. per week. There are never less than 16,000 natives at work in the mines in addition to white labour, and the annual municipal revenue administered by the Town Council, chiefly obtainable by a rate of 3d. in the £ on the value of house property, is upwards of £25,000.

That the diamond mines are destined to be permanently the greatest wealth-producing power of the country, has been ascertained by experiments of various kinds; and the shafting which has taken place proves that depth does not abate the yield of diamonds; and that the deeper the digging the better the quality, as those who have had experience in the Kimberley and other mines can affirm. The building trade flourishes more and more every year, as stores and residences are now built of brick and stone, and the great proportion of merchants, traders, and mechanics have made their homes, and settled down with their families, in the towns.

Sir Bartle Frere, at a banquet given in his honour at Kimberley this year, in speaking of the great progress, wealth, and importance of that place, said:—"Even if diamonds failed to-morrow, which they certainly will not do, Kimberley will always be a large, wealthy, and important town, it being the centre of the great interior trade of South Africa."

Since that time the London and South African Exploration Company have laid out a new town of great size on the Kimberley side of Du Toits' Pan, and not only has every building site been taken up, but already handsome stores and residences of brick and stone are in course of erection there, whilst Bultfontein has extended itself up to the boundaries of Du Toits' Pan.

The diamond fields are now part and parcel of the Cape Colony, which as the returns of the Crown agents show, is one of the wealthiest and most progressive of all her Majesty's colonial dependencies, and the 4½ per cent. debentures recently issued for the annexation of Griqualand West to the Colony were placed at £102 to £103.

London, Nov., 1880.

APPENDIX E.

Ostrich Farming.

The following sound remarks on ostrich farming are from a late number of the "Squire:"—

"I don't think ostrich farming may be fairly said to date further back than the year 1865. I know that when I arrived in the colony, in 1863, such a thing was unheard of, indeed it was not until 1870-1-2 that any appreciable advance was made.

"The ostrich (*struthio camelus*), as Macaulay's "every schoolboy knows," is a bird of the desert, its habitat the boundless, mirage-distorted, sun-scorched, dreary Karoo. So extensive are his feeding grounds and rapid his movements that fifty or sixty miles are often travelled by him, in a wild state, between daybreak and dark.

"How, then, were the subjugation and domestication of this lord of the desert achieved? For the most part by securing the chickens when very young, or else by procuring the eggs, and hatching by artificial incubation, so that in a very few years in the place of tens as many thousands might be counted in both provinces, east and west. Indeed, so rapidly did they increase, that great fears were entertained by many that over-production, and consequent depreciation in value, would be the ruinous issue. But this was not to be. Nature in this, as in many other instances, apparently demands a penalty for domestication. Her laws being violated, and made subordinate to artificial methods, produced diseases of various kinds. I have known instances of whole broods dying off suddenly, without any apparent cause, in spite of every care, attention, and treatment. Numbers die from exposure to cold and wet—from broken legs, intestinal entozoa, stoppages in the intestines, diseased liver, and various other causes. If not in a sound, healthy state, a cold rain is almost sure to prove fatal. As an instance, I once had a flock of nine-month-old birds exposed to a rain of two days' duration. They got so thoroughly saturated, exhausted, and chilled, that they could not be brought home to a place of shelter. Even after the weather had cleared up, one of the poorest-conditioned was so completely numbed that he could not be induced to walk a step, and had to be carried home in front of a man on horseback, wrapped in a wool bag. In this plight, almost lifeless, he was placed before a brisk fire, and a pint of warm gruel, with about half a tumbler of brandy, was administered to him. This, repeated at intervals of about twelve hours, entirely restored him, and I had the satisfaction of selling him some few months after for £25.

"A man to start ostrich farming fairly should have at least £1,500 capital. He would, in the first place, have to hire a good farm, say of 4,000 acres. This seems at first sight, especially to an inexperienced person, unnecessarily large. In good seasons, of course, it would be, but then one must reserve for times of drought and scarcity. For this farm, unenclosed—there being very few enclosed farms in the colony—he would have to pay a rental of about £150 per annum. To stock it he would require to purchase at least 100 young birds, at say £10 a piece—total £1,000. For £400 he could purchase three pairs of good breeding birds. These he would have to put in separate enclosures, or paddocks, of say ten acres in extent. Wire would be the cheapest fencing, drawn very taut, and wattled through from top to bottom with bush, as birds are liable to kick through and hook their legs fast, and often break them. And here let me add, a broken legged bird never recovers. The best and most humane way is to knock the ostrich on the head at once. You may bind and splinter the broken bone, but it doesn't help. He kicks, and struggles, and worries in his efforts to rise, that it makes the healing or uniting of the broken member a matter of impossibility. It is not unusual for birds, when playing or waltzing—which they do in the most graceful manner, whirling round on tip-toe with expanded wings—to drop down as if shot. You go up surprised to see what is the matter, and find a broken leg, snapped like a carrot.

"To return to the question of expenditure. We have supposed it to cost about £1,400 to stock the farm with birds. We have still £100 remaining. This would be required for purchasing wire, poles, implements, grain, &c. The first year's increase of three pairs of breeding birds would be about two broods each, of say ten in a brood. This is a low calculation. I have known a pair to bring out as many as four broods in one year; but they were exceptionally good. Thus from three pairs he would get sixty chickens. Their value would average about £10 each, so we have here £600 in chickens alone. The first crop of feathers from plucking birds, at an average of £1 per bird, would give £100. Total of first year's produce £700. Plucking birds of two years and upwards yielded, when I left the colony in April last, an average of about £8 per bird. The feathers are plucked, or rather cut, three times in two years or once every eight months. This is a very simple process. The birds are driven into a small enclosure, or yard, and packed so closely as not to admit of any room for shifting about. Then you take a clipper, lift the feathers with one hand, and cut with the other. The blacks, drabs, and tail feathers are always plucked—only the wing feathers are cut. In two months' time the points or stumps are drawn; they, being then hard and ripe, come out with ease.

"The ostrich feather is characterised by having the quill exactly in the centre of the feather, while in other birds it is a little on one side, causing the fringe on each side to be of unequal width. The elegance of the feathers, arising doubtless from their beautifully tapering shafts and delicate gossamer webs, has led to their being valued highly as articles of ornament in all ages. The Egyptians are supposed to have venerated them as a symbol of justice, from the fact of the width of the webs being equally balanced on each side of the shaft. In old paintings of Rembrandt and Vandyke, ostrich feathers hold a prominent position as ornaments in the hats of the bucks and bloods of the time.

"Ladies do not seem to have taken to them until a comparatively modern date. Now they have become so fashionable, that the deep-seated harassing dread in the bosom of the ostrich farmer is that they will become too common, and therefore be disused by the upper classes. But I think there is little fear of this, as really first-rate feathers will always maintain a price sufficiently high to preclude the possibility of their coming into general use.

"A very important *desideratum* is the obtaining of a good farm. Some farms are almost entirely worthless for ostrich farming, being destitute of very many requisites, such as salt bushes (*brak*), succulent plants, &c. An inexperienced person must on no account trust to his own judgment, or his venture is almost sure to end in disapointment and loss. If he has no friends in the colony, he should obtain introductions, either at Cape Town or Port Elizabeth, to some well-known breeder of respectability and standing. In a future article I shall endeavour to give some account of the habits and ways of the ostrich under domestication, and on the method of hatching, feeding, and rearing the young.—Alfred Evans."*

Vine Culture.

The cultivation of vineyards was one of the earliest industries established by Europeans in South Africa; the Dutch settlers soon found the climate and soil of their new home favourable for the growth of vines, and almost every settler had a patch of vines attached to his holding. But the more general and better treatment was derived from the French emigrants, who at once settled themselves down to this special cultivation; probably, however, the eminently conservative habits of the Dutch overcame the greater enthusiasm of their French neighbours; at all events, certain habits were acquired which

* A paper on the "Progress and Prospects of Ostrich Farming in the Cape Colony," by Mr. P. L. Simmonds, is printed in the Society's *Journal*, vol. xxiv., p. 228.

became fixed, and a treatment of vineyards was followed, not so much because it was good and suitable, as because it was the custom. This has continued pretty much, and with but rare exceptions, to the present day, and a uniform course is generally adopted irrespective of the questions of species, of soil, of aspect, of drainage, or of any other essential factor. Wines thus produced acquired a certain fixed character, and it is not so much that the European cultivator has advanced, as that the Cape farmer has stood still, that has operated against an improvement in the character of Cape wines. There have, however, been other evil influences at work. First, their merchants adopted the practice of giving a certain fixed price for wines each season, and the man who, with the least trouble, and by any means, produced a liquid, got the same price as one who had expended pains and care. Thus, the only consideration soon became quantity. Farmers took to planting their vines more in the valleys, and, not content with the natural moisture and swamps, actually, in many cases, led water courses through their vineyards; the result need not be commented on. The wine merchants having, as thus said, fixed the price of wine at the beginning of the season, bought from anyone as far as their means permitted, and emptied all their purchases into large, what are called, "stuckvats," holding from 800 to 1.000 gallons. Before this, however, the farmer had supplied the natural fermentation by large admixture of spirit, very badly made, and from which there had been no pretence of extracting the fusil oil. The wine now on the hands of the wine merchant was mercilessly dealt with, more spirit and compounds were introduced, until the raw wines delivered in April, May, and June were sufficiently "prepared" by the wine merchant to be sold as old matured wines by about November and December, with what result as to quality need hardly be said. Further, a great encouragement to the manufacture of bad wines arose from the protective Customs duties in England, all foreign wines paying 5s. 6d. per gallon, but colonial made wines only 2s. 9d.; thus, while this protection lasted, the differential duty admitted a very large importation of Cape wines, the quality of which continued to depreciate. No wonder that Cape wines, under such influences, acquired a bad reputation. On the alteration of the English wine duties, the Cape trade collapsed, and from that time the exports hence have been quite insignificant, and are almost confined to constructive wines, which, from their excessive sweetness, are rather liqueurs than wines. About three years since, a very energetic attempt was made to improve the character of Cape wines; some few gentlemen were impressed with the importance of rallying the most important industry in the western province, and from their knowledge of European viticulture, were persuaded that, with a most beautiful climate, a fertile soil, and good vines, only science was necessary to produce good wines. After very great labour and difficulty, they started a company called the South African Wine Growers' Association. Shares in this company were by degrees taken up, and the first act of the then appointed Board was to get out an expert from Europe thoroughly acquainted with wine growing and wine making. This gentleman was at first coldly received by the farmers, wedded to their old prejudices; but, as by degrees they realised the fact that the company would buy wines by quality, and pay an excess over anyone else for wines made on their system, the number of farmers making wine on the improved principle increased, but it is yet very far from general. The expectations of the promoters of this company are fully realised by the quality of their wines, which, of course, are as yet only two years old, but they show a promise of quality hitherto unknown, and such as must command a large European trade, but for the present, the home demand, *i.e.*, the colonial, is probably as much as they can supply. The prospects of the company are in every way excellent. It is not too much to say that the company promises to be one of the most remunerative and important institutions in South Africa.

The chairman of the Wine Growers' Association (before referred to) having gone through a large part of the French and German vineyards about a year since, partly for the business of the company, was naturally much alarmed at the rapid spread of phylloxera, and made this disease a careful study. On his return to the Cape, he felt with others that it was essential steps should be taken to prevent, if possible, the introduction of this pest to the colony, and very strong representations and petitions were presented to the Government, the result being, that all vines, cuttings, grapes, plants, tubers, and bulbs, were forbidden to be imported; the Government further, on the prayer of the petitions appointed a Commission to ascertain if phylloxera existed in the colony (as had been stated) and further, to report on the diseases really incident to our vines and viticulture generally.

Specimens of vines said to be affected with phylloxera, contrary to the distinct opinion of the Commission, have been sent to England, and submitted to Sir Joseph Hooker and Dr. Corner; unfortunately, the specimens did not arrive in good order, but so far as the before-named gentlemen could discover there was no trace of phylloxera; fresh samples preserved in alcohol are going home immediately for further investigation, but it may safely be affirmed that the disease does not now exist in the colony.

The labour and researches of this Commission promise to be most important, not only showing what diseases now exist, but how the different soils should be treated. Hitherto, a sort of uniformity of plan has been adopted, whether the soil was stiff clay or light calcareous soil; in fact, with but very few exceptions, viticulture here may be said to be half a century behind its condition in Europe. Further, it is the design of the Commission to prepare maps, showing the area occupied in wine farms, the number of plants on each, the soil and the aspect, when on a hill, &c. When this is done, the colony will, for the first time, know the real extent of this industry, at present, calculating on the area already examined, there cannot be much less than 150 millions of vines in the colony, and but a fraction of the land well adapted for this business is yet under that cultivation. For miles, running along one of our main lines of rail from Cape Town, hills ascend on either side, and, probably, no climate or soil in the world is better fitted for the cultivation of vines, and it is no exaggeration to say that there is an area in the colony of the finest soil for vineyards, capable of supplying the whole world, if the devastations in Europe progress. Many people affect to sneer at the Cape wines; but, though it is undoubted they were bad, it is proved that they can be made excellent, and there can be no doubt that further scientific applications will show, as in Europe, continually improving results. It is at first sight somewhat surprising that European capital and talent has not more largely sought this country; but a wine farmer is not a very ready emigrant, time and capital are required, and comparatively few emigrants can afford to wait three to four years, which would be occupied in bringing a vineyard into good bearing. Already, however, pioneers from Europe are beginning to turn their attention to this industry, and provided only we can keep out the phylloxera, viticulture will form as important a source of wealth to this colony as it has proved in France.

APPENDIX F.

Agriculture.

Memo of Information Furnished by Walter Peace, Esq., Emigration Agent for Natal, 21, Finsbury-circus.

Coffee.—Crop in 1870, 960 tons. Quality classed as "Plantation Ceylon," very good. Crop gradually

declined for years after 1870, and is now only again beginning to increase. Reason—Planters got an idea that continually pruning would "help nature;" they "bled the trees to death." Since the planters have allowed nature to do the work herself, the growing of coffee is beginning to pay again. Instead of using the knife, the planters manure the trees.

Sugar has a history in Natal similar to that of most other cane-growing countries. The beginners had neither the practical knowledge requisite, nor the necessary capital. Fifteen years ago Natal planters thought that only flat lands were suitable, now the bulk of the crop is grown on hill lands. The planting season is September to November. The first crop is ready about 21 months after being planted. The cotton crops follow at intervals of from 15 to 18 months; generally at least three crops are taken from the same plants. On some few rich alluvial flats, as many as 10 or 12 crops have been taken without the land being re-planted. First crops on good land, if with ordinary favourable season, and if the weeds be kept down, are calculated to give $2\frac{1}{2}$ tons (5,600 lbs.) per acre, besides treacle, which is afterwards distilled into rum. Succeeding crops, called first rattons, or second rattons, are expected to yield not less than $1\frac{1}{2}$ tons (3,360 lbs.). These figures are below the average experience of planters in good seasons, $3\frac{1}{2}$ tons of sugar per acre for first "plant cane," having often been obtained. The terms of sale in Durban are prompt cash. The average value, taking the average by shipments, is between 22s. and 23s. per cwt. White crystal sugar realises 28s. to 30s. per cwt. Yellow crystallised, 24s. to 25s. per cwt. Heavy syrup sugar, 17s. to 18s. per cwt. The "Central Mill" system has been at length successfully introduced at the the "Usine Centrale" in Victoria county, where growers of cane deliver their crop (by rail or by wagon), and, after the juice is extracted, the value of sugar contained therein is ascertained by testing the density of the juice. The grower can receive his payment for the proportion coming to him (calculated at about two-thirds of the value of the sugar at existing prices) without delay, the manufacturing company making a profit on the cost of manufacture out of the other third. The mill I refer to has cost from about £70,000, I hear, and will turn out 15 to 20 tons of white crystallised sugar per day. A mill capable of making 2 tons of sugar per day can be erected for about from £5,000 to £6,000, including all good buildings. The present crushing season is said to give the largest crop yet produced in the colony, and is estimated at 15,000 tons—worth over £300,000. As with coffee, "the lane seems to have turned," so with sugar; the losses of the past, which have been very heavy, and from many causes, seem likely to be compensated for in the immediate future, not, though, in many instances, to those who suffered the loss, but to others who have purchased estates which the former owners could not retain. Manuring the land for sugar-cane has only been resorted to as yet in very few instances in Natal.

Extract from the "Natal Witness," October 9, 1880.

PIETERMARITZBURG AGRICULTURAL SOCIETY.

One special general meeting and five committee meetings have been held during the year, all of which have been well attended. The subject of procuring the passing of a Fencing Law was under consideration at one of the above meetings, and a petition for the purpose was framed, after several discussions, and laid before the Legislative Council.

No legislation thereon has yet resulted, the subject being found to be surrounded with many difficulties.

The exhibits of live stock were, on the whole, satisfactory, all the pens erected for cattle, and most of those for sheep, being occupied by well-bred animals, many of which non-exhibitors were frequently overheard coveting the possession of.

The pens of cows and heifers were far superior to previous exhibits, and of bulls of various breeds there were a number of entries, most of them superior animals.

Sheep at this show almost surpassed the cattle in regard to merit—the pens of newly-imported Rambouillet merino rams which were exhibited being greatly admired for their size of carcase, length of staple, and quality of fleece. Several fine-fleeced Negretti rams were also exhibited, as also some pens of superior crossed Negretti lambs. In the classes of colonial merino ewes, cross-bred merinos, and Angora goats, the exhibits were good. Only two pens of fat wethers were shown from Boston district, by the breeder, Mr. James Stewart. Usually the town butchers compete for this prize.

Horses did not show up in numbers equal to some previous years. Those exhibited were, however, worthy of commendation. Only two imported sires were shown under Class 1, but of imported cart-stallions four fine animals were paraded in the ring.

The exhibits of produce, poultry, dogs, &c., inside the Market-house, fell far short of the display on some past occasions, but the quality as well as the variety of the exhibits in the produce and food classes were both interesting and worthy of the several awards which were made by the judges.

Wool, at present our principal exports from the uplands, has turned out well during the year, both in regard to yield and value, and sheep-farmers have been gratified in receiving good prices for their clips. The value of Natal grown wools, in the colony, during the year, has ranged from $7\frac{1}{4}$d. to $9\frac{1}{2}$d. per lb. for greasy, and from $10\frac{1}{2}$d. to $13\frac{1}{2}$d. for washed fleeces—condition, qnality, and length of staple determining the values. Large quantities of wool (yearly increasing) are now shipped as scoured snow whites, some parcels of which, being of good staple and well got up, have realised in London equal values with ordinary Uitenhage snow whites.

During the past year several importations of valuable live stock have taken place in the way of entire blood horses, draught stallions, Rambouillet and Negretti merino rams, and further arrivals are expected. With these and former importations we may in due course reasonably hope for considerable improvements in our flocks and herds. Several ostriches have also been introduced coastwise.

The erection of wire fencing continues to make increasing headway in various directions, and a large extent of land must have been thus enclosed since I last addressed you. Many, however, desiring to enclose their lands, or to form paddocks, are prevented doing so by the difficulty of procuring suitable labour for the purpose, or the needful timber for posts at a sufficiently reasonable price. As time goes on, fencing-in of lands will be adopted to a large extent.

One objection to wire fencing is its partial invisibility, and consequently the liability of stock getting entangled therein.

One sign of substantial progress and economising of labour that has come under my notice during the year is the successful application and use by Mr. G. H. Richardson, of Faulklands, near Pietermaritzburg, of the steam plough, and of the harrows worked by the same agency—200 acres having, I believe, been successfully cultivated by the steam plough.

Agricultural prospects on the coast have very much improved during the past year, rain having been more frequent and evenly divided along the coast belt. Sugar, the staple export product of the coast, is reported to be yielding a good return, while the growing crops promise well for next season. The crop of 1879 amounted to about 8,000 tons. This year's crop is calculated to yield from 13,000 to 15,000 tons, at an average of

£20 per ton. This gives £260,000 to £300,000 as the probable returns from sugar this year.

Coffee has also turned out a better yield than for several years past, although many coffee plantations have been allowed to die out, or have been cropped with sugar since drought and the borer insect played such havoc with them. A few small plantations, or plots of land, on the coast, in Victoria County, also in other directions, are under tea culture, with fair success. A gentleman, resident at the Isipingo, informed me last week that, with the exception of the last two or three months, he had not purchased a single pound of imported tea for his household during six years past, using nothing but what he had himself grown, which he found to be of very good flavour. This shrub does equally well in many localities in our uplands. Arrowroot, cayenne pepper, ginger, and other exportable colonial product still continue to be grown on the coast, and are exported to a small extent. The delay frequently attendant on effecting sales and returns from London, tend to retard an extended production. These being articles of limited consumption and demand, have frequently to be held for months after arrival before sales can be effected at anything like fair market values.

Tobacco is grown in our midlands, but on the coast to a much larger extent, fully supplying all local demand for the unmanufactured article.

Mealies continue to be grown to a large extent by Coolies on the coast, these people requiring to dispose of their crops as soon as possible after reaping, to enable them to pay rent and other demands. The value of this grain rules low until the Coolies have sold out. Some 5,000 muids of coast-grown maize have lately been shipped coast-wise,—prices ranging from 7s. to 10s. per muid of 200 lbs., partially to supply a demand which will always exist at the Cape and Port Elizabeth—for the purpose of feeding ostriches—so long as we are able to compete against imported maize. At present the price of mealies on the coast has risen to 18s. and 20s. per muid. I believe some shipments of maize are shortly expected from Europe to supply the demand.

Cultivation on the coast during the last year or two has increased fully 50 per cent.—especially along or near to the lines of the railway—which has greatly stimulated the sugar and other enterprises.

I am much pleased to learn, from several sources, that a number of sugar planters, who have been able to avail themselves of the advantages offered by the large Central Sugar Mill ("The Usine Centrale") at Mount Edgecombe, in crushing and manufacturing their cane into sugar during the present season, have been highly satisfied with the results in every case, both as regards the quantity and quality of the sugars produced; and that several planters have expressed their intention to close their own mills next season, and crush their whole crop at the above splendid mill, which is estimated to be capable of turning out 2,500 tons of superior sugar in the season, to a value of, say, £50,000.

Some of these gentlemen, though forced to send their cane a distance of twelve or fourteen miles by rail (from the Umgeni), nevertheless intend to repeat the experiment. Here, then, is a proof of what I have before advanced as my hope and opinion, that the difficulties hitherto surrounding the production of sugar by persons of limited means is to be overcome by the Central Mill system—one party being employed solely in the more simple employment of growing, and the other in the manufacture of the cane into sugar, and thus the enterprise made a profitable one to both, as well as increasing the exports and wealth of the colony.

I casually referred to ostrich farming in my address to you in 1878, as then engaging a deal of attention in the Eastern Province of the Cape Colony. In July last, when travelling to Grahamstown, Graaf Reinet, and other places, I was much surprised, notwithstanding all I had previously heard regarding the prosecution of ostrich farming, at the extent to which the breeding of and dealing in ostriches had attained, and the large returns which are, in many instances, derived by the hatching and rearing, the purchase and re-sale of birds, and the crops of feathers which are plucked from them (according to the fancy of the owners) every six or nine months, as also at the large sales of feathers held on the market at Port Elizabeth, every week, on Mondays and Tuesdays, throughout the year. These sales average from £8,000 to £15,000 weekly, the first amount being considered rather a low return. The total value of feathers sold on this market alone (irrespective of sales inland, or in the Western Province, where ostriches are also bred), during the six months ended June 30th this year, totted up to £276,188 1s. 10d., and for the year 1879 the total sales were £391,129 11s. 8d. I think I may safely put down at least two-thirds of this sum as the returns from domesticated birds, the proportion of wild feathers being very small.

One gentleman, Mr. Distin, of Tafelberg-hall, Graaf Reinet district, has about 1,000 breeding birds and innumerable enclosures on his farm. He is supposed to realise at least £10,000 a year by ostriches.

The common prickly pear plant (*Opuntia vulgaris*), which, having spread itself over large tracts of country, had previously been considered a pest, and large sums spent by some landowners in attempts to eradicate it, is now found to be good green for ostriches. Stuck on a fork or stick, and run through a blazing fire to scorch the thorns, it is chopped up with or without lucern. Mealies and barley are also used to feed with.

I was informed that the first census taken of domesticated ostriches in the Cape Colony in 1863 was returned as 88 head. In 1875 the second census returned 22,000. The number is now believed to be quite 100,000. Companies are now being formed to prosecute ostrich farming.

Angora goats and ostriches have all but supplanted sheep in the Zwaart Ruggens and Graa Reinet districts, as being less liable to losses by droughty seasons. I lay before you two samples of Angora hair from a superior flock in the above district, from which flock I hope in a month or two to introduce six rams. This sample is taken from wethers, and is fully 12 inches in length, and of good lustre. This breeder's ordinary clip was sold at Port Elizabeth in July last at 2s. per pound. The market for this product is rather depressed just now.

APPENDIX G.

Steamer Lines.—Hull to Benguela.

Extract from a letter from Mr. A. K. Rollins, secretary to the Hull Literary Society, dated Cogan-house, Hull, 8th December, 1880:—

"The steamers to which I referred are those of Messrs. Bailey and Leetham, of this port, and of Lisbon. They write me as follows:—'In reply to your note of yesterday, our African steamers leave Lisbon and touch at the undermentioned ports on or about the following dates:—

Lisbon, leave 5th of each month.				
Madeira, arrive	about	8th,	leave about	8th.
St. Vincent, (Cape de Verde)	,,	14th,	,,	14th.
St. Jago, (Cape de Verde)	,,	15th,	,,	16th.
Bolama,	,,	19th,	,,	20th.
Principe,	,,	27th,	,,	27th.
St. Thomas,	,,	28th,	,,	31st.
Ambriez,	,,	3rd,	,,	4th.
Loanda,	,,	5th,	,,	9th.
Benguela,	,,	11th,	,,	13th.
Mossamedes,	,,	14th,	,,	18th.

Benguela,	arrive about	19th,	leave about	21st.
Loanda,	,,	23rd,	,,	27th.
Ambriez,	,,	28th,	,,	29th.
St. Thomas,	,,	1st,	,,	4th.
Principe,	,,	5th,	,,	5th.
Bolomas,	,,	8th,	,,	9th.
St. Jago,	,,	12th,	,,	13th.
St. Vincent,	,,	14th,	,,	14th.
Madeira,	,,	20th,	,,	20th.
Lisbon,	,,	23rd.		

"They also leave Hull about once a month.'"

DISCUSSION.

Viscount Sidmouth said that, as Sir Bartle Frere had invited questions on the subject of his paper, which was of so great interest at the present time, he should be glad of information upon one or two of the topics mentioned in it. First, in reference to the harbours on the coast; his own recollection of Durban was that it had a very bad harbour, and the same might be said of the harbour at Cape Town, Table Bay. The only good harbour was St. Simon's Bay, which lay quite out of the way of ordinary traffic. Supposing that, at any future time—without entering at all into politics—the Transvaal country should become developed, he would ask Sir Bartle Frere whether he considered Delagoa Bay possessed sufficient facilities for affording a good outlet for the products of that country. That appeared to be the only port on the East Coast where a natural harbour existed. Durban could hardly be so called on account of the dangerous bar at its mouth. He should like, further, to know whether Sir Bartle could give the meeting any idea whether the Portuguese Government, which holds Delagoa Bay, was disposed to develop that harbour so as to give facilities for future traffic. Another point upon which he would be glad of information was, as to the possibility of forming a depôt at Angra Penquena. Sir Bartle had mentioned the small group of rivers shown on the maps high up on the West Coast, and that European colonists had already found their way in that direction. Driven by stress of weather, some years ago, to seek an anchorage in that region, he had found it very deserted, and had, in the neighbourhood of the Island of Ichaboe, known for its guano deposits, hit upon a very good harbour, which he judged to be somewhere in the direction of the small group of rivers referred to. As Sir Bartle had stated, as he understood, that European colonisation had found its way there, he wished to know whether it would not be possible for a depôt to be formed at Angra Penquena.

Mr. J. Jones drew attention to specimens of some of the minerals mentioned in the paper, which had been furnished by Professor Tennant, including specimens of coal, lead, iron, and diamonds. Amongst the latter was one of the largest that had ever been found in the colony. It was estimated to be worth £10,000 sterling. He would remind the meeting that Sir Bartle was himself a member of the Turners' Company, through the agency of which, by another of its members—the Baroness Burdett-Coutts—the diamond trade had again been brought into eminence in this country, after having been lost since the reign of George II. It was by means of the premiums offered by this lady, that Clerkenwell had now attained the highest point in the trade of diamond-cutting.

Mr. Hall said Sir Bartle Frere's paper had the especial merit of pointing out the great advantages of South Africa as a field for emigration, and he should like to ask whether Sir Bartle, from his intimate knowledge of the country—considering its advantages and disadvantages, the country being destitute of a good coast-line, and harbours for mercantile purposes—really thought South Africa a good colony for British workmen to emigrate to. Every means of knowledge was possessed by the public of the conditions of Australia, Canada, and the United States, and, before the paper should be published, he would like to hear from Sir Bartle's own lips whether South Africa, in his opinion—with its disadvantages weighed against its advantages—was an eligible field for the formation of British settlements.

Sir Bartle Frere, with regard to harbours, explained that he had omitted reading that section of his paper *in extenso*, for want of time, having already detained the meeting so long, but he had mentioned Angra Penquena in it, and had pointed out that one of the great wants on that coast was an accurate survey by responsible surveyors of her Majesty's service. Fogs were there very prevalent, and good charts and sailing directions therefore would be of especial value. He felt no doubt that a very considerable coasting trade would, in the future, be carried on from that coast, and that it would be brought into direct communication with Europe as soon as her Majesty's Government could obtain good surveys of the coast. A considerable trade was already carried on, and steamers ran pretty regularly to Port Nolloth, near the mouth of the Orange River. They ran down southwards to the group of rivers mentioned, and dropped passengers at Angra Penquena. It was very difficult to give advice on the subject of Mr. Hall's question upon emigration; but, if one of the best climates in the world could be an inducement, emigrants would find that inducement in almost every part of South Africa. They would find no severities of heat or cold, and they could thrive there; and, above all, they would find old, settled communities of men of their own blood and race, and Dutchmen near akin to us, who would welcome them with as much hospitality as they would get in England, if they did not like to face the wilderness and make a home for themselves. The more he studied the question the more convinced he felt that there were few regions of the earth where an Englishman would be happier who was compelled to seek a home out of his native land. There could be no question that Delagoa Bay was a magnificent harbour, and that a short line of railway would make it very serviceable to the Transvaal; the meeting could readily draw its own conclusions as to the likelihood of this proving a place of very great importance in the near future.

Sir David Tennant (Speaker of the Cape House of Assembly) was delighted with the admirable manner in which the history, character, customs, and mode of life in the colony had been depicted in the paper, and he could fully confirm Sir Bartle's opinion as to its eligibility as a field for British emigration and enterprise. Few countries could equal it. Of course, emigrants going to South Africa must expect to rough it. One of the great disadvantages experienced by strangers was the condition of the labour market. Labour there was of a more independent and less reliable character than elsewhere, whether the fact was attributable to the climate, to the sparse population, or to the manners of the coloured races. They took life more easily, and enjoyed it to a greater extent, than working people in this country. Strangers would have that difficulty to contend with, but they would find that eventually things would smooth down. The insufficient supply of the labour market was one of the great disadvantages; and another difficulty of our labouring population, in emigrating, would be that they would have to enter the labour market, to some extent, as competitors with the coloured people. It was always as well to state difficulties, and not to present too glowing a picture; but any industrious, enterprising, sober emigrant would be sure to do well in any one of the South African colonies. The climate, the mode of life, and the facilities for communication, all tended to inspire the European with confidence in the country, and to give him the assurance that, with diligence, he would be able to

prosper and raise himself in the social scale. As regards harbours, at Cape Town, the chief town in the colony, Table Bay was shunned in former times from its exposure to storms; but what nature had denied, art had supplied, and, by means of the docks and the breakwater, it had now drawn a very large commercial and shipping traffic to the colony. It was a perfectly secure harbour in all weathers, and it was only to be regretted that the docks, when first planned, had not been made larger. Algoa Bay was more exposed, but improvements were to be made there, and, when they were completed, a safe and commodious harbour would be supplied to a most enterprising port, the Liverpool of the Cape; Port Elizabeth is virtually a roadstead, but the harbour improvements will, in the end, secure safety. On all those harbours a very large outlay had been made by the Colonial Government, which continued to devote a large expenditure to them. From Cape Town a railway ran northward into the country for 400 miles, which had feeders on each side all the way, and another railway ran also inland, the two together extending about 1,000 miles in length. Another line of 400 miles would probably eventually be extended to the diamond fields. As those districts now formed part of the colony, there was, of course, every desire on the part of the Government, to afford facilities for reaching them also by steamer. As Sir Bartle had said, the only safe and certain progress was to be achieved, not by the extinction of the native races, but by the amelioration of their condition, and by Christianising them. He concluded by moving a hearty vote of thanks to Sir Bartle Frere for his admirable paper, coming before them, as he did, with his great knowledge of the condition and wants of the country, and as the friend of the people of South Africa, and beloved by them all.

Mr. Peace said that even supposing for the purposes of trade and of industrial development, Port Elizabeth should never be so improved as to make it a good harbour, Port Natal furnished that requirement, as was proved during the late Zulu war in the disembarkation of the troops. Having known Natal for 16 years, he could say there was no colony to which he would so readily emigrate, if he had his time over again. He would advise sober, industrious men to go out there without the slightest misgiving, for they would find that there they would live an Englishman's life improved. A circular upon colonisation would be issued from the Colonial Office in a few weeks, which would give every information with regard to Natal, to those seeking it. Sir Bartle Frere had added another claim to the gratitude of the British public, by supplying, from his extensive experience, a knowledge of South Africa, so much wanted in this country, and of the promise for the future of that great dominion. He had much pleasure in seconding the vote of thanks.

Dr. Badger, after hearing the paper, felt inclined to doubt whether the locality of the Garden of Eden had not been wrongly supposed to lie at the juuction of the Tigris and Euphrates, and whether it should not have been fixed in South Africa. Much was now talked about the "three F's," but South Africa possessed "three C's,"—coal, copper, and cattle. Its industrial products might be made enormously useful, and he hoped that thousands of emigrants would be induced to leave the wild and uncultivable parts of Ireland, and find a home in South Africa. He trusted that, under the benignant Government of England, and the wise constitution of the Cape, Europeans and natives might be made happy alike under the Divine blessing.

Mr. R. Rawlinson, C.B., pointed out that roads, one of the first necessities of a new country, were being constructed in the Cape Colonies. With railways, roads, and irrigation canals, the country would soon become prosperous. With regard to the labour difficulty, the Kaffirs would only engage themselves for a term, and would then, in spite of every inducement, return to their people for a period of idleness. But Englishmen, too, were fond of observing St. Monday, and the natives only manifested the same desire for periods of idleness in a more rudimental form. If treated with kindness, they would gradually appreciate and adopt habits of civilisation, and would aid the Europeans in making the South African communities sound and prosperous.

Dr. Mann said it could hardly have been expected that Sir Bartle Frere would have been able to devote so much of his time to the service of the Society as he had in producing the admirable paper just read. One of the most valuable portions of the paper was the point made in it of the necessity for irrigation, in regard to the future of the country. Along one side of South Africa ran a range of lofty mountains, which were deluged with rain for six months of the year. That rain escaped to the sea by a very rapid fall, and for the next six months the country was parched; but as soon as that water should be properly husbanded, the land could be made to produce the most valuable harvests. Throughout many parts of it corn could not be grown at present in summer, but, when irrigated, the finest corn crops in the world would be produced in the dry, sunny season of winter. Since 1857, the most rapid progress had been made in the country. Then no steamers sailed for Natal, and to reach it, he had himself, in that year, had to take a passage to Calcutta, land at the Cape, and go on by colonial steamer. At that time, Natal was occasionally two months without letters from England. Now we read in the evening in London of the events that had taken place in the Transvaal on the morning of the same day.

A Member alluded to the construction of railways now going on at the Cape, and said that the colony, having now got a fair start, would, as greater progress in that direction continued to be made, become one of the finest countries in the world. The mountains along either coast formed natural reservoirs, and, by means of irrigation works, a plentiful supply of water for the country could be obtained.

Sir Bartle Frere, in acknowledging the thanks which had been given him, urged their indebtedness to an old and valued member of the Society for the addition he had made to the evening's instruction by the beautiful collection of minerals he had placed on the table—he alluded to Professor Tennant. He was glad to notice that the trade of diamond cutting had again taken firm root in this country, and that the interesting processes connected with it could be witnessed by visitors in the manufactories in Clerkenwell, through the kindness of the gentlemen who had been instrumental in planting the industry in London.

Mr. Jones added that in a recent competition between diamond cutters in Holland, France, and England, the finest result in polishing the rough gems had been attained by the workmen of Clerkenwell.

The Chairman, in putting the vote of thanks to the meeting, alluded to the gratifying fact that witness after witness should have risen in the room to testify to the extreme value of the paper, and to emphasise the gratifying account given from Sir Bartle Frere's experience of the present condition and future prospects of South Africa.

TENTH ORDINARY MEETING.

Wednesday, February 9th, 1881; Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E., Member of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Bolas, Thomas, 2, The Terrace, Turnham-green, W.
Chambers, William E., Eversfield, Sutton, Surrey.
Courteen, Henry, 336, Clapham-road, S.W.
Felkin, Robert William, F.R.G.S., Pennfields, Wolverhampton.
Kirkham, Thomas Nesham, 21, Abingdon-street, Westminster, S.W.
Lee, Edwin, 43, Devonshire-street, Keighley.
Le Rossignol, Francis, 1, Gresham-buildings, Basinghall-street, E.C.
Magniac, Arthur, 36, Hertford-street, Mayfair, W.
Martindale, William, 10, New Cavendish-street, W.
Murray, R. W., 179, Upper Thames-street, E.C.
O'Donnell, William Arthur Maxwell, 4, Gladstone-street, London-road, S.E.
Parr, Samuel, 7, Finsbury-square, E.C.
Pheasant, William Craster, 8, Edwardes-square, Kensington, W.
Rafferty, John Henry, 4, The Terrace, Richmond-hill, Surrey.
Swanzy, Francis, 147, Cannon-street, E.C.

The following candidates were balloted for, and duly elected members of the Society:—

Cole, Alfred Clayton, 64, Portland-place, W.
Cook, Henry, Barrow-in-Furness.
Gibbs, George L. M., 46, Grosvenor-street, W.
Green, Herbert, Tovil-house, Maidstone.
Liardet, John Evelyn, 4, Breakspears-road, Brockley, S.E.
Littler, Ralph Daniel Makinson, Q.C., 1, Plowden-buildings, Temple, E.C.
Lockyer, George, jun., Beaconsfield-house, Godolphin-road, W.
Lovegrove, James, 18, Urswick-road, Lower Clapton, E., and Town-hall, Hackney, E.
Lyte, F. Maxwell, F.C.S., Cotford, Oakhill-road, Putney, S.W.
Payne, Septimus, F.R.G.S., Castle-house, 44, Mildmay-grove, Mildmay-park, N.
Shuttleworth, Joseph, Hartsholme-hall, Lincoln, and Stamp End Works, Lincoln.
Wills, George Sampson Valentine, The Westminster College of Chemistry, 60, Lambeth-road, S.E.; aud 116, St. George's-road, S.E.
Wright, Bryce McMurdo, F.R.G.S., Hesket-house, 54, Guildford-street, Russell-square, W.C.

The paper read was on—

THE PRESENT CONDITION OF THE ART OF WOOD-CARVING IN ENGLAND.

By J. Hungerford Pollen.

In the remarks I am about to make on wood-carving, I shall not enter into the higher aspects of this kind of art. It is, indeed, one side or branch of the sculptor's art. Sculptors of the greatest attainments have left us statues, busts, medallions, and other objects equal to what has been accomplished in harder materials, ivory, marble, and bronze. Many small pieces in the South Kensington Museum, as Sir Philip Cunliffe-Owen can tell you, will fully satisfy those who look for what can be done in hard woods. But I shall have enough for my present object if I can call your attention to carving, not as a branch of sculpture in this higher sense, but as a handicraft of great use, and I may say of necessity, to the architect and the cabinet-maker—carving with sharp tools on softer, or only moderately hard, woods. The carving with which I am principally concerned, is executed in pine and ash. Walnut wood is more easily procured in Italy and France than in England, and it is of so fine and tenacious a grain, that it admits of more delicate workmanship than that which I wish now to advocate. Wood-carving is, unfortunately, at a low level in this country for the present; speaking generally, it is almost a lost art. The only traditional school that has come down to us has its home in the dockyards; even from that quarter it is being driven by iron and steel. Many persons present to-night may have observed at Vauxhall-bridge a ship-breaker's yard, and have been struck with admiration, as I have, of the admirable figure-heads of colossal proportions. sometimes to be seen there. They are well-proportioned, often dignified, designed and carved with a perfect feeling of propriety for the effect they produce, all being calculated to show from a distance. I do not know whether there are good artists still capable of these successes. It would be a real matter of regret that one or two of such works should not be preserved as monuments or studies, rather than be sawn up for firewood.

It would be unfair in a discussion on this subject to omit mentioning, with the highest honour, such a carver of fancy work as the late Mr. Rogers, and some half dozen great London firms of cabinet-makers. But his work, again, is of too refined a kind to be included in the remarks I am making; it is occasional work, equal to that of the Florentines, Romans, and Venetians of the 16th century. What we want now is such carving as one ought to expect from skilled joiners, from a regular craft, and at moderate cost. Artists, architects, furniture makers, and the employers of all of them, want good current work, worthy of the churches, state buildings, and houses we are building at such great cost all over the country.

How much of it do we see in the great churches of our day, or in public buildings, or in rich country houses? There is a certain quantity in the Palace of Westminster, not of much interest, but in general the poverty of this charming kind of decoration is mortifying. Doorways, doors, panelling have been starved down to yards, furlongs, and miles of the product of the moulding plane. Even this much of handiwork is generally replaced by the steam plane. A good deal even of what passes for good carving is produced by a machine which multiplies, by mechanical action, copies of any given figure. I suppose, too, that most of us have had experience of that dismal lodging-house furniture met with at watering places—black horsehair sofas, with gaunt backs, chopped into leaves and curves, and sideboards of the same character. On the other hand, look at the eagerness with which old chairs and furniture are bought up, not alone because they are old, but because a certain elegance is discernible in the simple carving which was all but universally bestowed on them less than a century ago.

Now, carving in wood is as necessary to good architecture as carving in stone. Many buildings that are not wanting in external dignity and even splendour, are finished from foundation to roof ridge without the help of a stone-cutter, but are well fitted in the matter of wood-cutting within doors.

The sole feature that gives interest to some old London houses is their carved wooden doorway and porch, *e.g.*, in Queen Anne's-gate, Westminster, and in some by-streets of the City. And this remark does not apply to civil buildings only. Wood-carving is the glory of many of our old churches, for wood is the material with which churches, like houses, are furnished.

As regards architecture, we have lived to see two revivals in this century—the Pointed style, and now, quite recently, public taste is setting in the direction of what is called by the venerable name of Queen Anne, in other words, classic or Italian architecture, as naturalised here in England by Jones, Wren, and their successors. Both classes of building are incomplete—absolutely incomplete—without wood decoration.

Architects have been in advance of carvers, and we see the exteriors of modern buildings far better understood than the interiors. Great exertions have been made by the late Sir Gilbert Scott, and other architects, to train carvers of stone, but much remains to be learned and practised by the carvers of wood. We seem to have stopped half way in our revivals; and, as I wish to direct attention to a want that seems to me very serious, I must proceed to notice these revivals in detail.

To begin, then, with the pointed style, considering the rate at which the world moves, and the rapid changes of fashion, this mediæval style has had a long reign. Pointed architecture has been more popular in our country than on the Continent, and the principles of its structure and decoration have been more widely, perhaps better, understood. Now what part has wood-carving had in that revival? We have rebuilt the Houses of Parliament, we have just finished the new Law Courts, and have erected churches innumerable. In how many of the latter shall we see carved *miserere* seats, crocketed canopies, or carved shrines? What progress has been made in regard to the fitting up of civil architecture? The throne in the House of Lords is, perhaps, the best piece of work in the Palace of the Legislature, but the general fittings of the building are devoid of interest.

Now let any one walk into Henry the Seventh's chapel, in Westminster Abbey, or that of St. George at Windsor, and imagine how dull and uninteresting either building would be without the stalls and canopies that rise 15 feet or 16 feet on either side. The stall work of both belongs to a late date in Pointed architecture—a period of decay—yet what noble achievements in woodwork these seats and canopies are! The *misereres*, or hinged seats, have brackets which serve as a sort of seat when turned up. The brackets are supported by masks, grotesque figures, or animals, with foliage, gracefully turned. The designs are quaint, humorous, and always carved with spirit. The carvers have been their own designers, and have evidently taken pleasure in their work. Perhaps a certain amount of humorous quaintness is characteristic of all good carving, whatever the date or style.

I think our modern churches look cold and dull, even where great sums of money have been spent upon them, from want of this kind of furniture, once so general.

Then, again, as to roofs; no structures could be grander than the great wooden roofs of the Middle Ages. Some were supported by king posts, queen posts, hammer beams, and a forest of smaller supports: intricate, yet not without regularity and order: and always having figures of angels with outstretched wings on the ends of the hammer beams. We have a superlative example in Westminster-hall. Smaller roofs of the same construction are to be seen in some churches of Norfolk. All of these are dependent for much of their interest on the carved figures that adorn them. Perhaps such costly undertakings are scarcely to be hoped for in our times. Yet the hall of Lincoln's-inn, with a beautiful roof, was erected by Mr. Hardwicke forty years since. With the exception of occasional restorations of college halls, I doubt whether we have followed the example set so long ago.

Another fine form of roof or ceiling one would gladly see reproduced more constantly is that of square panelling with carved leaf work on the points of intersection. Most of the ceilings we find in modern churches, or in houses built in the mediæval style, are merely panelled with rails moulded by the plane.

Now, is it reasonable to suppose that carved leaf work of this kind—light, bold, broad, and sinewy—though it is not of extraordinary difficulty, cannot be added to ordinary panelled work, because of the cost? As we see it in old work, it is simple and coarse, but effective. It does not require an accomplished hand for its execution. Yet the quick, ready hands from which such work ought to be producible with ease and at moderate cost, cannot be found.

In making such a statement, I feel bound to acknowledge the services to wood sculpture of Mr. Brindley and his pupils. He has restored stall work and tabernacle work of all kinds. But such skill is confined to very few firms in London, Peterborough, and perhaps one or two other favoured cities. We have nothing like the amount of skill and talent in the wood-carver that we can resort to in masons and carvers of stone.

If the mediæval revival has not seen a lively and growing school of architectural wood-carvers, ready to decorate stall work and tabernacles, panelled walls and ceilings; neither can we point to any solid achievements in modern mediæval furniture. One or two light and well-constructed pieces, such as sideboards, buffets, &c., have been seen in the great International Exhibitions. But in furniture, far higher accomplishments are required of the carver. Those old cupboards, cabinets, buffets, chests, of French or Flemish origin, which are to be seen in the South Kensington Museum, and picked up in shops, are carved not with mere leaf-work, but with figure subjects. Little compositions, illustrating old legends, form the chief decoration of this old furniture; but we look in vain for it in our own reproductions.

If we are to go on building, fitting up interiors, and making mediæval furniture, it is in the direction here indicated that we want training and practice. Something should be said as to the treatment of carved woodwork and carved furniture. Old work was partially gilded. In roofs where it had little light upon it, it was painted and gilt. It was never covered with glossy varnish, as so much of our modern woodwork is.

Let us turn now to the decorative woodwork of

a later period, spoken of sometimes as a sort of halfway step in the direction of Italian art, that purely domestic style which we call Elizabethan. It belongs, in reality, to the earlier revival in this country of classic or Italian architecture. It was neither so artistic in outline, nor so fine in detail, as the art of the time of Henry VIII. He had Holbein and other foreign artists in his pay—men educated under the revival. The period of Elizabeth was later. The kingdom was more or less isolated from Continental Europe, and our style of architecture, and of the woodwork and sculpture that belongs to it, became national. It is the Elizabethan house, its interior panelling, its fanciful carving, and massive furniture, which has retained so great a popularity down to our own times. Country houses of this kind have been re-fitted, and others built in recent times, and we continue to build them still. All the woodwork of the old houses has a distinct and national character. But it had this character owing to certain national prejudices, and to the difficulties that stood in the way of sending artists to Italy, to study in Rome or Florence, as was the custom of the various States of Germany, Spain, and the Netherlands.

Nevertheless, builders and projectors of Elizabethan houses aimed at following the lead of the artists of Italy. In that favoured land, the enthusiasm for antique art, and the success with which it was cultivated, were astonishing. Italian painters were often architects as well. They designed churches and houses; they caught up the threads of old traditions, and carried them out into a thousand delicate developments. Wood-carvers adopted the mouldings, capitals, brackets, arabesques, and leaf-work, which they found on ancient monuments. Though they borrowed these details from architecture, they modified, simplified, or multiplied them, according to the opportunities of the objects they had in hand, and the nature of the materials in which they had to work. In this respect, they did what wood-carvers had done for the Pointed style. The egg and tongue, the drip moulding, the ogee mouldings covered with leaf-work, had all been adapted to their service. But, in the hands of the earliest and finest carvers, an immense variety was introduced into these important elements of decoration. So also with capitals and brackets, the classic acanthus was put to universal use. It was varied in ten thousand ways. Yet we recognise in all these Italian capitals, or brackets, or scroll work, in which this leaf is used, the old type. We cannot but see, moreover, what a pregnant type of foliage it is, and how inexhaustible in its application, offering an endless field for variety, and yet preserving that unity which is one of the great principles of art.

Here are examples of a large and a small piece of furniture, belonging to the best period or Italian wood-work (bench and mirror). We must keep this Italian wood-carving before the mind, if we wish to understand that of our own country.

The peculiar character of our own Elizabethan art, and, indeed, of the contemporarary carving of France and Germany, and still more of Flanders and the states of the house of Burgundy, was due to the firmer hold in those countries of old mediæval ideas. We, in England, retained a great love for the old houses, old feudal customs, the state and hospitalities of former days. The Elizabethan house was still surrounded by a moat. It had courts and gate-houses. The doors were old ledge-doors of massive oak, sometimes pierced with shot-holes. Then we preserved the old tradition of one vast room, or hall, to which withdrawing rooms, and libraries, and galleries were offsets. Into the hall travellers and wanderers were welcomed. The entrance was a passage panelled off from it, so that access could be had through it to the rest of the house. Over this passage a gallery commonly led from one side of the house to the other, still across this great hall. These panelled screens and galleries are richly decorated with carving of several kinds. A huge fireplace was provided on one side. The upper end was raised, and the handsomest seats were placed there. There sat the guests of highest rank, on the wall side only. The salt, the emblem of hospitality, was placed in the middle of the table. Guests of inferior rank sat at tables running down the length of the room. The walls were panelled with oak, to a height of ten or twelve feet. These noble halls are, as we may say, "the making" of the Elizabethan house, as they had been of the earlier Tudor houses, and of old castles, and manors, and granges, time out of mind. The architectural diposition, inside and out, was, in great measure, dictated by that of the old pointed style. The Renaissance was adopted with enthusiasm, but the parts and details were fitted to a system of mullioned windows, pointed roofs, and Tudor arches. Builders thought one way; and expressed their thoughts in a borrowed language. We see curious façades, displaying sets of columns of the "Five Orders," one over the other. As to details of wood-work, the fireplace was put together over a Tudor arch, like all the doorways of the house. Round arches were of late adoption. The hall-screen had classical columns, capitals, and brackets. Terminal figures, with Ionic capitals, supported the large and projecting cornices. Both in these large screens and the chimney fronts, the details are curiously mixed in character. There are Doric columns from the ground; a second series over them; deeply recessed panels, fronted by arches; over all, generally the heraldic achievement of the family. The boldest carving is often seen in the details of heraldic carving; the mantlings of the helmet coming down in wide sweeps of wood carved in relief. Every detail in this kind of carving retained to a great degree its abstract and conventional design. In the richest and best examples of screens and fire-places, figure sculpture is employed. The virtues, for instance, in hooped petticoats or classic armour. Arabesque work, that is, animal heads or human masks, with scrolls of foliage, were carved with spirit, and used to cover imposts, or panel surfaces, or coupled together and spread out into cornices, and the upper borders of continuous panelling. Another favourite element of decoration is that scroll work of flat relief, with bosses of turned and split wood at intervals, called strap-work. The cornices of chimney-pieces, or screen divisions, are often interrupted by work of this kind lapping round it, and passing over members of the structure above or below. It would seem to be an idea borrowed from the old iron-work that formed so important a feature in the

chests, doors, and other wood-work of the middle ages. This strap-work, and the larger surfaces of it round heraldic scutcheons, borrowed, probably, from the notched and curled edges of boiled and stamped leather, are very effectively employed in Elizabethan wood-work. In one form or another, these pierced, plated, or curled decorations are met with on all sorts of surfaces. They are of great effect.

Then, again, look at the furniture of this system. The huge acorn table legs, with gadroon ribs on the upper, and acanthus leaves on the under surfaces. The same acorn shape elongated serves for stair balusters, and for supports to side-boards and cabinet fronts. Other notable objects of furniture are the bedsteads. The bed heads are divided into recessed panels, and the tester is supported by huge acorn posts, sometimes by fluted columns, much diminished as they rise. Rude terminal caryatid figures are generally introduced into the bed head. The tester is a panelled frame.

Most of the details of Elizabethan woodwork are meant to be Italian. The mouldings are partly run off from the plane, partly fitted in with billets or egg mouldings, but worked, it must be remembered, by uneducated carpenters, joiners, and carvers.

If we take Elizabethan carving detail by detail, it is full of faults, short-comings, and inconsistencies. It aims at a graceful and beautiful ideal; but it is carried out—often ignorantly—as best it can be. We recognise in it a real character; it is full of strange and even grotesque incident, but it speaks the mind of its day. And this is what gives spirit, life, and meaning to good intentions in the artist. The Elizabethan age was full of a strange medley of thought—chivalry, of a kind hospitality, courage, thirst for new adventure, for new knowledge—of affectation and simplicity—of generosity, though thirsty for wealth, and stained with cruelty.

If we attempt to reproduce wood-work belonging to that period, we must do it with some spark of love for the interesting side of an age so remarkable: and of art, so full of inconsistencies, or at least of compound ideas. If, on the other hand, we simply copy this old work, and with labour and neatness follow its oddities, without knowing how to modify their art in our turn, as they modified Italian art in theirs, we do but reproduce the grotesque side of it. The neater, the smoother, the more mechanical the imitation, the more glaring become the faults of our work. Any architect who has had to take work of this kind in hand, and to get it executed, will, I think, agree me as to the unsatisfactory results he has often to meet. It is to be remembered that the wood-work of the Elizabethan time was cut by country workmen, and it is astonishing that hands so well practised in the actual business of carving should have been found in every county in England, from Northumberland to Cornwall. Could we go to any assize town now and reckon on finding two or three master wood carvers and their apprentices, ready to carry out panelling, heraldry, furniture—all that is wanted to fit up a stately palace according to the taste of the day? No; I fear that out of London, or Peterborough, or one or two other favoured towns where some man of special training has made a school for himself, we should search for what we want in vain.

Well, let us turn to a later fashion, that which is becoming so popular now under the name of Queen Anne.

Two great architects put the principles of the Italian Renaissance into exact form in the 17th century—Inigo Jones and Christopher Wren; Vanbrugh, Chambers, Kent, Adam, and others followed. Numerous examples of the wood-work designed by these artists remain in public buildings, churches, and dwelling-houses. They had fewer decorative resources than their contemporaries in Italy and France. One great name, however, belongs to the profession of wood sculptors of the century, that of Grinling Gibbons. His foliage, flowers, birds, and other details have the sweep and delicacy of Nature, so far as an approach to Nature can be carried in decorative carving. All the carving of the 17th and 18th century may be called architectonic. It was put to the service of interior decoration. Let us notice it in detail. Houses were no longer built with the great halls already noticed. Churches, however, and large public halls, such as those of Greenwich Hospital, Kilmainham Hospital, in Dublin, and other places, were often screened off from the doors. Such screens are regular and orderly façades, with arched entrances, surmounted by a pediment. The walls of these structures, and of rooms generally, were divided by columns or pilasters, fluted, and with carved Corinthian capitals. The panelling is no longer of the old sizes, but in very large divisions; one of dado height, with tall panels above. They stand well out, and are enclosed within bold roll mouldings, projecting beyond the surface of the panels. Where these panels are of great size, as in some public halls, the mouldings were carved. Wreaths of leaf-work stand out in relief on the architraves, that finish the wall panelling; and that surmount the openings of fireplaces and doorways. These doorways, even inside the rooms, are generally covered by a pediment. The picture frames that form the upper portion of the chimney fronts, are also surmounted by a pediment, pointed, or round, or interrupted in the middle. Garlands of leaves or flowers, with bold side brackets, in the form of volutes, over which the foliage falls, or from the eyes of which another scroll of leaf-work springs, form the side decoration of the chimney fronts of the more correct Wren period.

I should be taxing your patience too far were I to attempt to follow the wood decoration of this fine character through all its details. We may, however, notice some special features, out of which the wood-fitters and joiners of the last century may be said to have made their decorative work, and these are the very elements we want our wood-cutters to have at command to-day.

First, figure sculpture. Somehow in this country, our wood-carvers have never been strong in this essential matter. Even in Wren's time, and that of his successors, beyond an occasional artist, there does not seem to have been any possibility of commanding the services of carvers educated to this extent. We find heads—of cherubs, of women, &c.—occasionally well modelled and finished. But the contemporary Italian and French wood-cutters could beat us out of the field in this respect.

Of foliage, the English carvers were masters

As for the foliage of Gibbons, it was of all kinds, and animals were introduced among the rolls of his stems and flowers. It was abundant, and yet delicate. Generally, he used lime-wood; and his work is such as naturally found its place as an addition to actual architectural details, and was applied to friezes, or placed under pediments, or on the architrave fronts of chimney pieces. Such carving as that of Mr. Rogers, had more of it been devoted to decoration, would be invaluable in these reserved spaces. (Some of Gibbons's carving can be seen over the communion-table of St. James's, Piccadilly.)

It is to be noted that, in architectural carving of this period generally, the acanthus and the vine leaf are the only leaves employed. There is, also, the honeysuckle ornament, and anthemion, or leaf arrangements similarly composed. In later work—Adam's, for instance—the olive, or a leaf of similar shape, was added. Speaking generally, however, the leaf used is the acanthus. It is cut on capitals and under brackets. Portions are composed over the surfaces of mouldings, in a hundred varieties, and with endless inventiveness. Yet it is always recognisable, and helps to preserve the unity of the general design of the decoration. The little, feather-shaped leaves on the correct English Corinthian capitals seem to me the poorest and driest examples of its use.

On the furniture of Queen Anne's time you see the acanthus leaf on the bulging legs of chairs and tables; and broken pieces of it on the tops of bed testers, on chimney pieces, and round looking-glass frames. The finer, more wiry work of Adam, and the Chippendale furniture, is decorated with sprigs, or portions of this leafage. And some small Adam mouldings are entirely worked in tiny acanthus, even when the width scarcely reaches 3-8ths of an inch.

As to mouldings, something may be said. Mouldings, of course, represent the decoration of edges. Wood being framed together often in different thickness, these edges have to be provided for. The decoration of wood edges takes so large a place in the arrangement of panelling, of picture-frames, of fireplace openings, doorways, and so on, that it forms the most noticeable decorative feature at the command of the carver.

It is worth observing, how few the mouldings of these periods are. They are derived from classic Rome. There is the egg and tongue; leaf mouldings; billet mouldings, made up of small square dies separated by hollows; bead mouldings; ribbon mouldings (guilloches); square key frets; the Vitruvian scroll; little else. Yet few as these are, the shades of variety to which they lend themselves are endless; partly by the size, partly by the shape of the egg and the anchor, or by carving the egg surfaces, or by various treatment of the acanthus leaf-work, where it covers the surface of the moulding lines.

The carvers of the last century cut these in soft pine, over long lengths of moulding; often in beautiful curves and turns of the leaf. A slip of the chisel would have destroyed the side of the doorway. There are examples in the Kensington Museum, taken from old London houses, quite complete, and of masterly execution. Could we be sure of getting such sharp, free-handed work done now?

Then as to furniture. Chambers introduced Chinese fret-work, and the Chippendales cut those delicate pierced cabinet tops, and china shelves, and table edges, which are so highly prized now. The carving of looking-glass frames took the form of little Chinese gardens, with rocks, grottoes, argus pheasants, and other curiosities down the edges. As far as architectural carving was concerned, how very few and simple are the elements of this old carving—carving so much in request now. I wish I could think that our Queen Anne style was fitting itself out with these simple, yet effective, elements of carving. It is a kind of work which all carvers could learn; which will always return full and redundant measure of effect and agreeableness, for the modest skill it requires. Some London firms well understand this kind of carving; but only two or three establishments. Putty, or papier maché, or other moulded imitation, are generally provided by the builder. Look at our picture frames, and the feeble meanderings of putty over their surfaces, and compare them with the simple honest mouldings of the Vandyck frames. I do not forget the admirable objects we have seen at various International Exhibitions. They are triumphs of skill, and the exhibitors, English, French, Italian, or German, deserve all honour. But these are objects of special and extraordinary exertion of artists, and are monumental—not works that can be placed within the reach of ordinary buyers, or made without excessive cost of time and labour.

I shall conclude with one or two observations which I hold to be of the first importance, and which, I think, may be deduced from the foregoing remarks. First, all decorative carving in wood, mediæval and Renaissance, has been intimately connected with architecture; and, further, has been architectonic in design and details. The tabernacles, pinnacles, and spires of mediæval stall-work, triptychs, and so on, are designed on the lines of external architecture. So with door pediments—really, small roofs—pillars, capitals, architraves, and so on.

How is it that wood, so different a material from stone, and being used in-doors under such different conditions from those that govern exteriors, should fall under the rules and lines of actual architecture? Ought not all wood-work to be governed by some distinct principle of decoration? I believe that most designers have asked themselves this question, and battered their brains for an answer. In many cases the honest endeavours of many architects and cabinet-makers show that an answer has been sought, and the general results show how rarely it has been found. Sooner or later, I believe, we must all come round to the principle which has prevailed so generally, if not so universally, in the past. Good art maintains its unity. Architecture is the master art in a certain true sense. Sculpture and painting find their true places under its shadow. Great buildings, cathedrals, temples, abbeys, and halls of justice belong to all who can see and use them; in the case of religious buildings, to all who care for religion in the whole world. Pediments, gables, arches, columns, and so on, not only represent fundamental geometrical figures, which rule the composition of decorative detail, but they are parts of structures the most imposing, the most intimately associated with

national life, that come within the range of our imaginations. They connect interior decoration with the structure for which they are intended, and give a certain life and purpose to details that could not effectively stand alone. On this part of the subject there is much more that might be said, but, after all, the strongest proof of the necessity of the connection I advocate, is the broad experience of all history.

Of course, the architectonic character in question is one of analogy. Wood carving should be suggestive, not imitative, of architecture. It is on a lighter and a broader scale of proportions, in accordance with the continuity of fibre and tenacity of grain of wood as contrasted with stone. The most cursory study of examples will set this clearly before us.

Another observation I make is on the extreme simplicity of the elements out of which such endless varieties, both before and since the Renaissance, have been produced in carving—one or two kinds of foliage, half a dozen types of moulded edges. Some of these are convex in sections, some concave, some undulating.

One of the most dangerous stumbling-blocks to modern carvers, men who have not well read or thought the subject out—one of their most serious impediments—is the vast variety of fragmentary examples in museums. They belong to various periods, and represent many phases of change. The student aims at producing something new. In art, novelty—actual novelty—is rarely to be had. The traditions of art, descending through the long ages of the past, reveal to us the unity of principle which they maintain, not less than the simplicity of the instruments, by means of which successes so many and so various have been achieved. Michelangelo learnt his inspirations from studying a few sarcophagus fronts and other marble fragments in a garden. The architects of his day, and of Wykeham's, and of Wren's, began by mastering the few decorative details in use in their day. What a slender stock of tools, for works so infinite in variety, that have come down to our time! They were students of nature as keen and true as ourselves, but they sought variety rather than novelty, in perpetual freshness of application, of few but inexhaustible principles. What they did, sculptors and carvers, decorative carvers, can do in their degree in our days.

Then, again, if to narrow our field is in reality to increase our insight and inventive powers, it follows that modesty, self-restraint, and simplicity of aim, should govern our designs of ornamental carving. Look at the decorative carved work, such as one sees, for instance, on sideboards; bunches of game, pheasants, hares, rabbits, hung all over it. Some of these compositions are skilfully carried out; but the impression they produce is that of redundance, crowding, want of discrimination, absence of effect, good work often wasted. You see ornamental details heaped on mirror frames, cabinets, chimney fronts. Such compositions are vulgar, because the artist has chosen details, perhaps from several good original examples, which do not agree with each other. They are like fine expressions or musical rhymes torn from their proper contexts.

To compose really well, to know exactly where to stop, and how to make a simple piece of foliage or figure set off the space it fills; to possess what we mean by a correct taste, is partly a gift, partly the fruits of thought and observation. To pick and choose, and mingle together in the search of novelty and variety, is the least likely way to acquire it.

If the desire to put too many ornaments is the danger of composition in carving, so to try to follow nature too far is the danger in execution. No leaf, or flower, or other object followed up to realisation, really decorates the frieze or the the wood-work on which it is carved; it is better to carve it complete, and lay it on a table, or in a cabinet. When we decorate a frieze, or a cabinet, the ornaments are to be portions of the thing decorated, and worked out, some more, some less, according to the size, shape, amount of plain surface, and so on. Leaves die into the surface, or are only indicated over many places, on the bell of a capital, the tympanum of a pediment. Points in the leaf are here and there fully developed. Figures in bas-relief are often of extreme flatness, or partly flat and partly brought fully out and undercut. Much foliage that would be excellent if indicated only, one sees absolutely spoilt by attempts to elaborate petals, leaves, tendrils, and so on. Even natural proportions have frequently to be modified. Carved objects will often not look correct without this severe treatment.

Opportunities of careful rendering of nature are never wanting to the carver, and his finer skill and deeper knowledge produce their true effect, when he knows how to keep other portions of his work subdued, or but partially defined, and strictly subordinate to architectural requirements.

DISCUSSION.

The **Chairman** said there was perhaps hardly anyone else in the country so competent to give such an interesting and instructive paper as Mr. Pollen had just read, and he thought he must have had practical experience, not only of carving in stone, but in wood also. It had occurred to him, while listening to the paper, that it was a great pity that his words should only be heard by those then present, and how well it would be if the lecture was repeated in workshops, or centres of industry, where he was sure it would not only be listened to with interest, but would be followed by good results. In England, we were in a very peculiar position as regards the art of wood-carving. He had before him the prospectus of a School of Art Wood-carving, which was founded in 1879, by a few of his colleagues at the South Kensington Museum, who, with an eminent manufacturer and other gentlemen, banded themselves together for the purpose, one of the most active being the gentleman who had the direction of the science schools throughout the kingdom. He thought Colonel Donnelly must have taken this up as a kind of relaxation, probably thinking it not so dry, and a little more artistic, than what he had to do, and did so successfully, in connection with the science schools. This was only started in 1879, whilst in Austria, Hungary, Switzerland, and most countries of Europe, the Government promoted schools of wood-carving in all parts of their dominion, and one of the most interesting sections of the Exhibition at Vienna, was the one showing the results of the teaching throughout the primary schools of the Austro-Hungarian Empire. This school was still in its infancy at the Albert-hall, but it had already attracted the attention of the City Guilds of London Institute for advancing Technical Education,

and he trusted that it might become a normal school for other schools throughout the kingdom. After all, wood-carving was a thing which interested almost everybody; boys and even girls were very fond of carving, and they often carved most inconvenient things with their pocket-knives. Now, if this disposition were turned into a right channel, and they were taught in the various schools how they might make use of this love of carving for the decoration of their houses, great good would be done, and much evil would be avoided. It was a matter which ought to be taken up generally, and he trusted Mr. Pollen would repeat his lecture in other parts of the metropolis. He heard, the other day, that 60,000 new houses were built in London and its suburbs every year, and, of course, with such a state of things, there could not be much time spent on decorative wood-work, but there were many people who would willingly introduce wood-carving for decoration, if there were carvers to do the work. He believed that until latterly there had been no means of instruction whatever, except in some of the large firms, until Signor Bulletti, the instructor of this school, tried to start a school of his own. They owed his presence in England to the liberality of the late Duke of Northumberland, and some of the most marvellous carving of modern times was to be seen at Alnwick Castle, as the fruit of his work. He regretted that Mr. Pollen had not applied to the South Kensington Museum for more specimens to hang upon the walls, for he was sure they would have been lent. After all, the South Kensington Museum was one of the children of that Society, and they were always pleased to have an opportunity of showing honour and respect to their parent, the Society of Arts, which initiated the Exhibition of 1851, and had supported every movement connected with instruction throughout the kingdom.

Colonel Donnelly said he had come to learn and not to teach, and he certainly was not prepared to enter at a moment's notice on the large subject of wood-carving generally, but he might say a word or two about the school which had been alluded to as one of the means by which the art might have a chance of revival He spoke, of course, of wood-carving in the architectonic sense, not as developed in some of the beautiful specimens exhibited, which might be looked upon more in the light of pictures than as accessory decorations. The school was really established with the aid of the City companies, and fortunately they had rooms lent them by the Royal Commissioners for the Exhibition of 1851. This school had been a striking example of the difficulties which were met with in attempting to found technical education, by which he meant, not general or special science or art-teaching, which might be useful in any particular branch of art or industry, but the absolute learning of the *technique* of the art. If you attempted to teach the *technique* of an art or trade in existence, those whom you taught could not get employment in the trade; they had not been entered in it, and it was almost impossible for them to get into it. If, on the other hand, you took up an art which had nearly died out, with a view to its revival, you found it very difficult to get pupils, because they naturally asked, "Shall we be able to find employment for our art when we have learned it?" On the other hand, those who might employ them did not design for wood-carving, because the art having died out, there was nowhere where they could get it done in the quantity and with the rapidity necessary in carrying out large business operations. This was really one of the great difficulties in the way, which would only be got over in time, but he hoped that some architects, who were now designing Queen Anne mansions by the hundred, would remember the School, and give them some orders. They were getting into a state in which a good deal of really good work might be carried out, though they could not undertake very large orders at present, but if they were encouraged, they would soon get more pupils, who would see their way to an occupation in life. One great advantage was that it was an art which ladies could follow, and become as skilful in as men. They must, however, have some artistic feeling, and must first learn drawing and modelling. It was not to be taken up by anybody therefore, and when persons had learned drawing, and had some art appreciation, they did not know whether wood-carving was an occupation by which they could earn their bread. If the work was to progress, it must be with the co-operation of architects; but he must thank Mr. Pollen for the opportunity he had given to advertise the schools, and perhaps if some of the daily papers would be kind enough to abuse them a little, it would also further assist them.

Mr. Rogers said it seemed to have been assumed for some time past that the art of wood-carving in England was a lost art, but he could not agree to this view. A large proportion of the wood-carvers in England, and especially in London, had not for many years had full employment; he might safely say that one-third of them had been out of employment three months in the year for some time past. It was a lost art, simply because it was not looked for. If the work Mr. Pollen had described had been inquired for during the last ten years, it could be had. He saw men there, whose works he knew, though he might not have spoken to the men themselves, capable men, who had not been fully employed. He first heard the statement about four or five years ago, since when it seemed to have taken root in the public mind, and he was glad to have an opportunity of correcting it. He believed it arose from an article in the *Builder*, stating that some architect wanted to get some work done in London, and could not get it done there, and had to send it to Paris. A great deal was made of that at the time, but the gentleman explained afterwards that the trade just then happened to be very busy, and this work, which was wanted in a hurry, could not be done in time, but he had all he could executed in England, and he was much better pleased with the English work than the French. These explanations, however, were very often not seen by those who saw the first assertions, and so it got about that work could not be done in England. He did not believe, however, that any architect would say so. There was a great deal of first-rate furniture being made which was never seen by the public. Customers would order things to their own taste, or from a design by their architect, and, as soon as it was done, it was sent home, and, therefore, there was no opportunity of judging of it by the general public. When he was acting, in connection with Mr. Donaldson, at a recent Exhibition, he had a letter from an artisan, Mr. Aumonier, saying he had some fine things near completion, but he could not spare them for so long a time; and asking if he might be allowed to send one piece for a fortnight, and then take it away, and send another, and so keep his work before the public. That was not permitted; but it struck him then that if some suitable place in London could be found, where carvings, as they were finished, could be shown for a few days before they were sent home, the public would be better able to judge of the real position of the art. He had been much pleased with the paper, and should like to move a vote of thanks to Mr. Pollen.

Mr. Mansfield thought Mr. Rogers's remarks were worthy of consideration; and he could exemplify them by his own experience. A short time ago, he had some fine pieces of furniture in the warehouse, just finished; and by chance Mr. Graham and Mr. Donaldson called in, and saw them; they asked if they might send their workmen to see them, to which he readily agreed, and the first night 300 men came; many of them were so pleased that they asked if they might come again the next night and bring their friends; and on the following evening more than 1,000 came. He would gladly

extend that kind of thing if he could, even to opening the place on a Sunday. It was certainly to be regretted that things were passed out of hand so rapidly, that the working classes had no opportunity of seeing what was done. His opinion was, that as good work could be done now as ever, if it were ordered.

Mr. Wolstencroft referred to the fact that many wood-carvers had been thrown out of employment by the abandonment of carved work on carriages. The idea of exhibiting good work for a short time was a good one, because manufacturers did not care to make things specially for exhibitions where they were locked up for six months and perhaps not disposed of at all. He had seen in the manufacturer's shop, a few days ago, a beautiful specimen of wood-carving which was sent to both the Vienna and Paris Exhibitions, and was still unsold.

Mr. Mackay said he was a member of the Wood-carvers' Society, and knew something about the subject. He and his fellow members of the trade were much pleased to find this subject engaging the attention of the Society, and of the gentleman who had read the paper, but there were points in it with which he could not by any means agree. There was a disparaging tone in it, which he doubted very much if those practically acquainted with the subject would endorse. No doubt wood-carving had passed through several phases during the last forty years. In 1851, there were glaring faults; in the Paris Exhibition of 1857, and the English Exhibition of 1862, there was a change for the better; and in 1878 it found its proper place, which it had not done before. Mr. Pollen had spoken of sideboard carvings being overloaded with game and so on; but they did not see such things now, and he did not think the improvement had been dwelt upon as it deserved. As to the idea of the art being lost, and that it was only to be revived by this school which was directed by Signor Bulletti, he dissented from that altogether; there was a lot of life in it still; and he failed to see how Signor Bulletti, with all his ability, and all the influence he had to back him, was going to revive it. Nor were the works exhibited last year at South Kensington such as would warrant those who had produced them, and their friends, in believing—and it must mean that or nothing—that they would be able to gain anything like a subsistence. He thought they were going on the wrong road, which would only lead to disappointment. His feeling was that although help could be given out of doors, and technical instruction could be afforded in schools, the workman must remain in the workshop. It was there only that the man or boy could be trained to be a workman. As to the other sex, with all due respect to the ladies, he believed that, except as a pastime, it was altogether a mistake for anyone to advise them to take to it as a remunerative employment. No doubt workmen were not so advanced as they should be, but if they were to do much, architects must come to their assistance, tell them what they wanted, and give them directions. If the architect would put up with sham and shoddy, the public would also, and the workman had to walk the streets, or to produce that for which he had a dislike, which did no credit to him, and brought the art into disrepute.

Mr. Sandilands (secretary of the Wood-carvers' Society) said there were several present who could speak more as to the present state of wood-carvers than of wood-carving. When he heard of this lecture, he wrote to the Secretary of the Society, who kindly sent him six tickets, but if he had sent him one hundred, he could have used them all, and have brought that number of men, who could have spoken feelingly as to the present condition of wood-carvers. It seemed to have got abroad that the wood-carver was almost an extinct animal, and that the art had to be revived by some means or other, and that this school at South Kensington was to be one means of doing it. Colonel Donnelly thought that if the school was abused a little, it might be to its advantage, and he could assist him with any amount of abuse; but if that was the object of reviving wood-carving, it was not one which wood-carvers would want to assist. If it was to compete with the profession, and to invite architects and manufacturers to send work to it to be done by the students, and young men, who had little or no pay, how was it possible that men established in business, who had to pay liberal wages to their workmen, could compete with them—supposing that they were able to do the work—which remained to be seen. There were any amount of wood-carvers equal to any work which could be entrusted to them, but they could not stand alone, like painters, or sculptors; wood-carving was an accessory art, which depended on architects and designers for its existence. He would undertake to say that any number of men could be found in London to carry out all the work which was required, and if that was not the case at that moment, more would soon come forward. When work was wanted, it had always been found that men soon qualified themselves to accomplish it. The Houses of Parliament had been alluded to as showing unsatisfactory work; but it must be remembered that when they were built, that kind of work was very little known; but, at the present time, any quantity of it could be done equal to anything to be seen in old examples.

Mr. Pollen said very possibly he had failed to make himself fully understood as he had intended. He started by referring to several specimens of fine work, and said that the best work could be done to-day, as good as that of the old Venetians and Florentines—there were examples in that room, only just completed, as fine as anything Grinling Gibbons did. His point was not that it was a dead art in that respect, but he asked the question as a matter of fact—how much wood-carving did you see in modern Queen Anne houses? There were all sorts of cornices and ornaments, but they were all mouldings. He built a house himself, not long ago, and the first thing which occurred to him was, to have the ledges and styles of a pair of mahogany folding-doors carved. He obtained estimates; and he had specimens in his hand, the price of which was 2s., 1s. 9d., and 1s. 6d. a foot. If he had had the doors carved in that way, it would have added £10 or £15 to the price, which hardly any one could afford. Wood-carving was practically a lost art in that sense, that the price at which you could get it done was prohibitive—it was out of everybody's reach. What was wanted was a simpler style of thing, which an architect could order 500 or 600 feet of at a moderate price. The fine specimens referred to were, he believed, only turned out by very large firms. As to the school, he had only referred to some of the specimens as having been produced by it. He believed it was not started by Signor Bulletti, but by Colonel Donnelly. His object was to train people to common-place ground-work; so that if there was a demand for it, it could be had.

The Chairman, in moving the vote of thanks to Mr. Pollen, said they might congratulate themselves that there had been several members of the Wood-carvers' Society present, and he wished there had been, not six, nor sixty, but a hundred and sixty. He hoped there would be another paper on the same subject, when the members of the Wood-carvers' Society would come in a body. But however those who were present might dissent from certain remarks made by the lecturer, they would, at all events, acknowledge his kindness in coming forward and drawing attention to the subject, and he trusted they would so prepare themselves for a future occasion, as to really benefit the public. To that end, he would announce that any number of copies of the *Journal* containing the

lecture would be sent to the members of the Wood-carvers' Society, if Mr. Sandilands would send word to the Secretary how many were required. Mr. Mansfield's remarks deserved the greatest possible credit; but he was not astonished at any act of liberality on the part of Messrs. Wright and Mansfield. It was like them to call together their competitors in trade to see what they produced, and he only wished other firms would follow the example. It would be an excellent thing to find a place where such objects could be sent for a few days; workmen would learn to respect one another, and they could have no better critics than those in their own trade. He knew of no work more appropriate to the Society of Arts than that it should endeavour to institute such an arrangement. Some had objected to the idea of wood-carving being in a dying state, and it was a great satisfaction to know that they need never say die; and, in order to show architects and gentlemen who were willing to spend money on their houses that it was not an art which had died out, they ought to look forward another year to some special exhibition of wood-carving as applied to architecture. That would show the world generally that there was life in the old dog yet, and that there was no reason to despair.

The vote of thanks was carried unanimously.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The following report, as to the action of the Society in founding the School, has been prepared by the Secretary, by order of the Council, and was considered at a recent meeting:—

1. In 1860, negociations were commenced between the Council of the Society of Arts and the Directors of the Royal Academy of Music, on the subject of the reform of the Royal Academy. In November of that year, a Committee was appointed to consider the subject, and to confer with Sir John Harington and the Directors of the Academy. In May of 1861, this Committee reported, stating what they considered the principal objects of a Royal Academy of Music, and stating that, in their opinion, an enlarged scheme of a National Academy of Music should be based on the foundation of the present Royal Academy. In February, of 1865, the Council appointed a Committee to consider the state of Musical Education at home and abroad. In June, 1866, this Committee published a voluminous report, containing the evidence of a number of musicians and others who had been examined by them. The report stated that for the proper cultivation of Music, a National Academy of Music, supported by Parliamentary funds, was requisite, and that such an Academy should afford gratuitous education to persons having great musical gifts, who, after their training, would become professors of Music. The Committee recommended that the Academy be open to the public on payment of fees, that scholarships should be endowed, and that the Society of Arts should found a limited number of such scholarships. They also recommended that the application made by the Royal Academy, in 1854, to the 1851 Commissioners, for a site on the Kensington-gore Estate, should be renewed.* After the publication of this report, negotiations seem to have been continued with the Academy, but they were brought to a close in 1868, as appears from a letter from Mr. T. T. Bernand, addressed to Mr. (now Sir) Henry Cole, by the fact that the Academy found themselves unable to surrender their charter without going to considerable expense.*

2. In December, 1870, the Musical Committee recommended the Council to make arrangements for a series of concerts to be given at the Royal Albert Hall, the profits of such concerts to be applied to the establishment of a National Training School for Music. Six concerts were given, with the net result that a loss of about £100 was incurred by the Society.

3. In the opening address delivered on behalf of the Chairman, Lord Henry Lennox, on the 17th of November, 1871, appears a statement to the effect that the Council were of opinion that the time had arrived when public opinion would justify them in taking active measures for promoting the establishment of a National Training School for Music. It then goes on to suggest that the school should be established in connection with the Albert Hall, and expresses a hope that the Commissioners of 1851 would supply the funds. In 1872, the Musical Education Committee of the Society was joined by H.R.H. the Duke of Edinburgh, and in 1873 a meeting of this Committee was held at Clarence-house, with his Royal Highness in the chair. At this meeting Mr. Cole stated that the Corporation of the Royal Albert Hall was willing to supply accommodation for students, and that application had been made to the Commissioners of 1851 for a plot of ground on the western side of the hall. He added that the Royal Academy of Music "was not in a position in which the Society could avail itself of the services of that body." His Royal Highness expressed his regret that the Royal Academy could not be made the basis for the National Training School. Eventually, it was resolved:— "That it is desirable to erect a building at a cost not exceeding £20,000, for the purposes of a Training School for Music at Kensington, in connection with the Society of Arts." "That a Sub-Committee be appointed to consider on what terms and on what conditions that sum may be raised, in shares or otherwise, and that such Sub-Committee consist of the Duke of Edinburgh, Mr. Tufnell, Mr. Freake, Major Donnelly, and Mr. Cole."

4. This Sub-Committee prepared a report, which was submitted to the General Committee, and afterwards to the Council. It states that the Society of Arts had decided "to take the initiative, and establish a Training School, by voluntary effort, with the full intention and confident hope that it will eventually be transferred to the responsible management of the State." It proposed to establish about 300 free scholarships. These were to be of two kinds—one affording free instruction, the other free instruction and maintenance. It was added that should there be more accommodation in the school than was requisite for the instruction of the free scholars; students paying their own fees would be admitted by competition to fill vacancies, "care being taken that they show sufficient aptitude." Some propositions were made

* Report of Society of Arts Committee on Musical Education. 1866. Price 5s.

* See also Sixth Report of H.M. Commissioners for the 1851 Exhibition, Appendix O, p. 99.

as to the arrangements for the purchase of land and the erection of a building; but as these were not carried out eventually, it seems needless to refer to them. The last paragraph of this report ran as follows:—"Lastly, it is proposed that the school shall be commenced as soon as possible, under a Committee of Management, consisting of two members appointed by the Royal Commissioners for the Exhibition of 1851, two members appointed by the Council of the Royal Albert Hall, and three members appointed by the Council of the Society of Arts." The Sub-Committee were requested to prepare plans and estimates.

5. It is not, perhaps, necessary to refer in detail to the way in which preparations were made for the foundation of the school. It may be sufficient to say that eventually Mr. Charles J. Freake undertook to erect the school at his own cost. This fact was announced by the Prince of Wales at a meeting of the promoters, held at Marlborough-house on the 9th of July, 1875. The Commissioners of 1851 provided the site, near the Albert Hall, free of charge, and the corporation of the Albert Hall undertook to lend certain of the rooms, and a theatre, in the Hall, for the use of the students. On the 18th of December, 1873, the first stone of the building was laid by H.R.H. the Duke of Edinburgh. This event was celebrated by a concert in the Albert Hall, at which his Royal Highness spoke. After referring briefly to the early history of the negociations, he said, "There was a pause in the labours of the Society of Arts, and those labours have now extended over about 15 years; but there was another pause, which occurred at my own suggestion, on account of a thought on my part that the two institutions might have been united into one. I myself undertook negociations with the Royal Academy of Music with that view; but, after some considerable time had been spent in them, we found that the principles on which the two institutions were founded were so far apart, that it was not advisable that they should be united into one. The Royal Academy has but few free scholarships for those who have displayed a knowledge and aptitude, but have not means; the fundamental principle of the school we are assembled this evening to celebrate the foundation of, is the free scholarships for all ranks of society."

6. The school was opened, in 1876, with 82 free scholarships, of which four were founded by the Society of Arts, two by members of the Society of Arts, five by Mrs. Freake, ten by the Corporation of London, fourteen by some of the City Guilds, thirty-three by provincial towns, nearly all of which were obtained through the agency of the Society of Arts, the money for the purpose being voted on the understanding that, so soon as the school should be able to afford it, the cost of obtaining these scholarships should be refunded to the Society.*

7. The objects for which this school was founded were set forth in the report above referred to, published by the Musical Committee in 1873. This report was issued as a draft prospectus for the school at that time, and the substance of it was embodied in the first Directory issued by the school. In the Directory it was stated that "the fundamental principle and primary object of the school is the cultivation of the highest musical aptitude in the country, in whatever station of society it may be found. In order to carry out this principle to the fullest extent, admission to the school will be obtained by competitive examination alone. A Training School for Music founded thus, on the basis of free instruction, given only to successful competitors in public examinations, occupies a field of action wholly distinct from that of any existing institution."

8. The amount spent previous to the foundation of the National Training School for Music, by the Musical Educational Committee, was £217. Since the foundation of the school, in 1873, there has been spent £956, exclusive of the Society's Scholarships, which amount to £800. The Society has also held examinations in Music since 1859, in connection with its general system of examinations. The charges of these cannot well be separated from the General Examination charges. The fees for the Examiners in Music, however, amount to £214, while £194 have been paid for prizes. The total amount which the Society may be said to have expended upon Musical Education, and the National Training School for Music, is £2,382, of which £1,756 have been spent directly upon the school, during the past seven years.

* See Minutes of Council, 19th May, 1874.

MISCELLANEOUS.

ROSE OIL, OR OTTO OF ROSES.

By Charles G. Warnford Lock.

This celebrated perfume is the volatile essential oil distilled from the flowers of some varieties of rose. The botany of roses appears to be in a transition and somewhat unsatisfactory state. Thus the otto-yielding rose is variously styled *Rosa damascena*, *R. sempervirens*, *R. moschata*, *R. gallica*, *R. centifolia*, *R. provincialis* It is pretty generally agreed that the kind grown for its otto in Bulgaria in the damask rose (*R. damascena*), a variety induced by long cultivation, as it is not to be found wild It forms a bush, usually 3 to 4 feet, but sometimes 6 feet high; its flowers are of moderate size, semi-double, and arranged several on a branch, though not in clusters or bunches. In colour, they are mostly light-red; some few are white, and said to be less productive of otto.

The utilisation of the delicious perfume of the rose was attempted with more or less success, long prior to the comparatively modern process of distilling its essential oil. The early methods chiefly in vogue were the distillation of rose-water, and the infusion of roses in olive oil, the latter flourishing in Europe generally down to the last century, and surviving at the present day in the South of France. The butyraceous oil produced by the distillation of roses for making rose-water in this country is valueless as a perfume; and the real otto was scarcely known in British commerce before the present century.

The profitable cultivation of roses for the preparation of otto is limited chiefly by climatic conditions. The odoriferous constituent of the otto is a liquid containing oxygen, the solid hydrocarbon or stearoptene, with which it is combined, being absolutely devoid of perfume. The proportion which this inodorous solid constituent bears to the liquid perfume in-

creases with the unsuitability of the climate, varying from about 18 per cent. in Bulgarian oil, to 35 and even 68 per cent. in rose oils distilled in France and England. This increase in the proportion of stearoptene is also shown by the progressively heightened fusing-point of rose oils from different sources: thus, while Bulgarian oil fuses at about 61° to 64° Fahr., an Indian sample required 68° Fahr.; one from the South of France, 70° to 73° Fahr.; one from Paris, 84° Fahr.; and one obtained in making rose-water in London, 86° to 89½° Fahr. Even in the Bulgarian oil, a notable difference is observed between that produced on the hills, and that from the lowlands.

It is, therefore, not surprising that the culture of roses, and extraction of their perfume, should have originated in the East. Persia produced rose-water at an early date, and the town of Nisibin, north-west of Mosul, was famous for it in the 14th century. Shiraz, in the 17th century, prepared both rose-water and otto, for export to other parts of Persia, as well as all over India. The Perso-Indian trade in rose oil, which continued to possess considerable importance in the third quarter of the 18th century, is declining, and has nearly disappeared; but the shipments of rose-water still maintain a respectable figure. The value, in rupees, of the exports of rose-water from Bushire in 1879, were—4,000 to India, 1,500 to Java, 200 to Aden and the Red Sea, 1,000 to Muscat and Dependencies, 200 to Arab coast of Persian Gulf, and Bahrein, 200 to Persian coast and Mekran, and 1,000 to Zanzibar. Similar statistics relating to Lingah, in the same year, show—Otto: 400 to Arab coast of Persian Gulf, and Bahrein; and 250 to Persian coast and Mekran. And Bahrein — Persian Otto: 2,200 to Koweit, Busrah, and Bagdad; rose-water: 200 to Arab coast of Persian Gulf, and 1,000 to Koweit, Busrah, and Bagdad.

India itself has a considerable area devoted to rose-gardens, as at Ghazipur, Lahore, Amritzur, and other places, the kind of rose being *R. damascena*, according to Brandis. Both rose-water and otto are produced. The flowers are distilled with double their weight of water in clay stills; the rose-water (*goolabi pani*) thus obtained is placed in shallow vessels, covered with moist muslin to keep out dust and flies, and exposed all night to the cool air, or fanned. In the morning, the film of oil, which has collected on the top, is skimmed off by a feather, and transferred to a small phial. This is repeated for several nights, till almost the whole of the oil has separated. The quantity of the product varies much, and three different authorities give the following figures:—(*a*) 20,000 roses to make 1 rupee's weight (176 gr.) of otto; (*b*) 200,000 to make the same weight; (*c*) 1,000 roses afford less than 2 gr. of otto. The colour ranges from green to bright-amber, and reddish. The oil (otto) is most carefully bottled; the receptacles are hermetically sealed with wax, and exposed to the full glare of the sun for several days. Rose-water deprived of otto is esteemed much inferior to that which has not been so treated. When bottled, it is also exposed to the sun for a fortnight at least.

The Mediterranean countries of Africa enter but feebly into this industry, and it is a little remarkable that the French have not cultivated it in Algeria. Egypt's demand for rose-water and rose-vinegar is supplied from Medinet Fayum, south-west of Cairo. Tunis has also some local reputation for similar products. Von Maltzan says that the rose there grown for otto is the dog-rose (*R. canina*), and that it is extremely fragrant, 20 lbs. of the flowers yielding about 1 dr. of otto. Genoa occasionally imports a little of this product, which is of excellent quality. In the south of France, rose gardens occupy a large share of attention, about Grasse, Cannes, and Nice; they chiefly produce rose-water, much of which is exported to England. The essence (otto) obtained by the distillation of the Provence rose (*R. provincialis*) has a characteristic perfume, arising, it is believed, from the bees transporting the pollen of the orange flowers into the petals of the roses. The French otto is richer in stearoptene than the Turkish, nine grammes crystallising in a litre (1¾ pint) of alcohol at the same temperature as 18 grammes of the Turkish. The best preparations are made at Cannes and Grasse. The flowers are not there treated for the otto, but are submitted to a process of maceration in fat or oil, ten kilos. of roses being required to impregnate one kilo. of fat. The price of the roses varies from 50 c. to 1 fr. 25 c. per kilo.

But the one commercially important source of otto of roses is a circumscribed patch of ancient Thrace or modern Bulgaria, stretching along the southern slopes of the central Balkans, and approximately included between the 25th and 26th degrees of east longitude, and the 42nd and 43rd degrees of north latitude. The chief rose-growing districts are Philippopli, Chirpan, Giopcu, Karadshah-Dagh, Kojun-Tepe, Eski-Sara, Jeni-Sara, Bazardshik, and the centre and headquarters of the industry, Kazanlik (Kisanlik), situated in a beautiful undulating plain, in the valley of the Tunja. The productiveness of the last-mentioned district may be judged from the fact that, of the 123 Thracian localities carrying on the preparation of otto in 1877—they numbered 140 in 1859—42 belong to it. The only place affording otto on the northern side of the Balkans is Travina. The geological formation throughout is syenite, the decomposition of which has provided a soil so fertile as to need but little manuring. The vegetation, according to Baur, indicates a climate differing but slightly from that of the Black Forest, the average summer temperatures being stated at 82° Fahr. at noon, and 68° Fahr. in the evening. The rose-bushes flourish best and live longest on sandy, sun-exposed (south and south-east aspect) slopes. The flowers produced by those growing on inclined ground are dearer and more esteemed than any raised on level land, being 50 per cent. richer in oil, and that of a stronger quality. This proves the advantage of thorough drainage. On the other hand, plantations at high altitudes yield less oil, which is of a character that readily congeals, from an insufficiency of summer heat. The districts lying adjacent to and in the mountains are sometimes visited by hard frosts, which destroy or greatly reduce the crop. Floods also occasionally do considerable damage. The bushes are attacked at intervals and in patches by a blight similar to that which injures the vines of the country.

The bushes are planted in hedge-like rows in gardens and fields, at convenient distances apart, for the gathering of the crop. They are seldom manured. The planting takes place in spring and autumn; the flowers attain perfection in April and May, and the harvest lasts from May till the beginning of June. The expanded flowers are gathered before sunrise, often with the calyx attached; such as are not required for immediate distillation are spread out in cellars, but all are treated within the day on which they are plucked. Baur states that, if the buds develop slowly, by reason of cool damp weather, and are not much exposed to sun-heat, when about to be collected, a rich yield of otto, having a low solidifying point, is the result, whereas, should the sky be clear and the temperature high at or shortly before the time of gathering, the product is diminished and is more easily congealable. Hanbury, on the contrary, when distilling roses in London, noticed that when they had been collected on fine dry days the rose-water had most volatile oil floating upon it, and that, when gathered in cool rainy weather, little or no volatile oil separated.

The flowers are not salted, nor subjected to any other treatment, before being conveyed in baskets, on the heads of men and women, and backs of animals, to the distilling apparatus. This consists of a tinned-copper still, erected on a semicircle of bricks, and heated by a wood fire; from the top passes a straight tin pipe, which obliquely traverses a tub

kept constantly filled with cold water, by a spout, from some convenient rivulet, and constitutes the condenser. Several such stills are usually placed together, often beneath the shade of a large tree. The still is charged with 25 to 50 lbs. of roses, not previously deprived of their calyces, and double the volume of spring water. The distillation is carried on for about 1½ hour, the result being simply a very oily rose-water (*ghyul-suyu*). The exhausted flowers are removed from the still, and the decoction is used for the next distillation, instead of fresh water. The first distillates from each apparatus are mixed and distilled by themselves, one-sixth being drawn off; the residue replaces spring water for subsequent operations. The distillate is received in long-necked bottles, holding about 1¼ gallon. It is kept in them for a day or two, at a temperature exceeding 59° Fahr., by which time, most of the oil, fluid and bright, will have reached the surface. It is skimmed off by a small, long-handled, fine-orificed tin funnel, and is then ready for sale. The last-run rose-water is extremely fragrant, and is much prized locally for culinary and medicinal purposes. The quantity and quality of the otto are much influenced by the character of the water used in distilling. When hard spring water is employed, the otto is rich in stearoptene, but less transparent and fragrant. The average quantity of the product is estimated by Baur at 0·037 to 0·040 per cent.; another authority says that 3,200 kilos. of roses give 1 kilo. of oil.

Pure otto, carefully distilled, is at first colourless, but speedily becomes yellowish; its specific gravity is 0·87 at 72·5° Fahr.; its boiling-point is 444° Fahr.; it solidifies at 51·8° to 60·8° Fahr., or still higher; it is soluble in absolute alcohol, and in acetic acid. The most usual and reliable tests of the quality of an otto are (1) its odour, (2) its congealing point, (3) its crystallisation. The odour can be judged only after long experience. A good oil should congeal well in five minutes at a temperature of 54·5° Fahr.; fraudulent additions lower the congealing point. The crystals of rose-stearoptene are light, feathery, shining plates, filling the whole liquid. Almost the only material used for artificially heightening the apparent proportion of stearoptene is said to be spermaceti, which is easily recognisable from its liability to settle down in a solid cake, and from its melting at 122° Fahr., whereas stearoptene fuses at 91·4° Fahr. Possibly paraffin wax would more easily escape detection.

The adulterations by means of other essential oils are much more difficult of discovery, and much more general; in fact, it is said that none of the Bulgarian otto is completely free from this kind of sophistication. The oils employed for the purpose are certain of the grass oils (*Andropogon* and *Cymbopogon spp.*), notably that afforded by *Andropogon, Schœnanthus* called *idris-yaghi* by the Turks, and commonly known to Europeans as "geranium oil," though quite distinct from true geranium oil. The addition is generally made by sprinkling it upon the rose-leaves before distilling. It is largely produced in the neighbourhood of Delhi, and exported to Turkey by way of Arabia; it is sold by Arabs in Constantinople in large bladder-shaped tinned-copper vessels, holding about 120 lbs. As it is usually itself adulterated with some fatty oil, it needs to undergo purification before use. This is effected in the following manner:—The crude oil is repeatedly shaken up with water acidulated with lemon-juice, from which it is poured off after standing for a day. The washed oil is placed in shallow saucers, well exposed to sun and air, by which it gradually loses its objectionable odour. Spring and early summer are the best seasons for the operation, which occupies two to four weeks, according to the state of the weather and the quality of the oil. The general characters of this oil are so similar to those of otto of roses—even the odour bearing a distant resemblance—that their discrimination when mixed is a matter of practical impossibility. The ratio of the adulteration varies from a small figure up to 80 or 90 per cent. The only safeguard against deception is to pay a fair price, and to deal with firms of good repute, such as Messrs. Papasoglu, Manoglu and Son, Ihmsen and Co., and Holstein and Co., in Constantinople.

The otto is put up in squat-shaped flasks of tinned copper, called *kunkumas*, holding from 1 to 10 lb., and sewn up in white woollen cloths. Usually their contents are transferred at Constantinople into small gilded bottles of German manufacture for export. The Bulgarian otto harvest, during the five years 1867-71, was reckoned to average somewhat below 400,000 *meticals*, *miskals*, or *midkals* (of about 3 dwt. troy), or 4,226 lb. av.; that of 1873, which was good, was estimated at 500,000, value about 700,000*l.* The harvest of 1880 realised more than 1,000,000*l.*, though the roses themselves were not so valuable as in 1876. About 300,000 *meticals* of otto, valued at 932,077*l.*, were exported in 1876 from Phillipopolis, chiefly to France, Australia, America, and Germany.

PROVINCE OF ASTERABAD AND ITS INHABITANTS.

Asterabad is situated in the south-east corner of the Caspian Sea; its inhabitants do not exceed 45,000, and the town of Asterabad can only boast of 8,000 souls. It is bounded on the south by the high range of mountains which separate the Persian Caspian provinces from the other parts of Persia. On the north it is bounded by the Atrek as far as Chat, situated at the confluence of the Sombar and the Atrek; beyond that point it is doubtful where the boundary lies in that direction. The west is bounded by the Caspian Sea and the province of Mazanderan, and in the east it is adjoining to the province of Meshed. Gez, Molla, Kellè, and Gumush Tèpè are the only ports in the province in use. The former is in weekly communication with the other ports of the Caspian by means of the Mercury and Kafkas steamers, and although but a small village of 150 houses, it is the emporium of all the trade carried on between the civilised world and north-east Persia. English manufactures, French sugar, and Russian hardware find their way through Gez to Meshed and Herat, while Yezd opium, Meshed carpets, Sebzewar silkworm eggs, Damghan lead, Asterabad cotton and wheat find an outlet through Gez. The province of Asterabad is well wooded, and is watered by numerous mountain streams. The principal districts are those of Anazan, Sedem, Rustak, Asterabad Rustak, Katoul, Finderisk, Shahkou, and Salwar. The inhabitants of Asterabad mostly belong to the Kajar tribe, of which the Shah of Persia is the chief; members of the Tat tribes are also to be met with. As head of the Kajars, the Shah possesses considerable estates in the province, which are farmed out to various individuals, giving a rental of £7,700. The fertility of the soil, wherever it has been cleared of the overhanging forest, is wonderful, producing as much as from 60 to 120 bushels for one bushel sown. The timber in the forests is magnificent, and in any other country it would form a source of great riches, but over the whole extent of the province there is not a single road worthy of that name, and the traffic that penetrates into the interior has to wend its way on horseback through the forests and through the rice fields.

Parallel with the Elboorz, and at a distance of 20 miles to the north, runs the river Gurgan, about 60 miles long. Fifteen miles or so north of the Gurgan is the Atrek. Between these two rivers is to be found the most fertile soil that can possibly be imagined, and it is on this strip of land that the Turkomans pitch their obehs; the Yemoots between the sea shore and Gombuz-i-Kabous, 60 miles inland; and the Goklans between this point and Kari-Kaleh. The Yemoot tribe of

Turkomans number about 80,000 families, of which, however, only about 20,000 have anything to do with Persia. They are sub-divided into two distinct tribes, named, respectively, Jaaferbai or Sherif, and Attabai, or Chuni. The Jaaferbai Turkomans comprise two grand divisions—the Yar Alis, and the Noor Alis, each having various sub-divisions of its own. The Attabai Turkomans have also two grand divisions—the Attabai proper, and the Ak. Each of these divisions comprise two classes of Turkomans, called respectively, Charvai, and Chumour, that is to say the rich or noble class, which can afford to move about from place to place, and the poorer class, called Chumour, whose means do not enable them to move away from the banks of the Gurgan. The Charvai are in the habit of moving towards the north, as far as the Balkan mountains, near Krasnavodsk, twice a year. When the harvest is ripe, these nomads return to the Gurgan. The Chumour are the people, generally speaking, who are addicted to man stealing. The amount of tribute paid by the Yemoot Turkomans to the Persian Treasury is 2,000 tomans; it is collected both in money and kind, such as carpets and felts. Advantage is frequently taken hy the Persian authorities, of any discord reigning among the Turkomans themselves to increase the amount of taxation, and the Turkomans seize the first opportunity to recoup themselves on the villagers of Asterabad. The Goklans were formally 12,000 families, but owing to the constant attacks made upon them by their Persian neighbours, the Saad-el-Loo Kurds of Boojnoord, they have now been reduced to 4,000. They inhabit the rich plains, situated on either side of the Gurgan, east of Gombuz-i-Kabous. The amount of tribute paid by the Goklans to the Treasury is 6,000 tomans, which is collected by Yar Mohammed Khan, of Boojnoord, and handed over to the Government of Asterabad.

Besides the regular caravans, a large number of pilgrims pass through the province of Asterabad every year from the western shores of the Caspian Sea, proceeding to the Holy Shrine of Reza, the seventh Imaum of the Shias, whose tomb is in the city of Meshed, in Khorassan, and to defray the expenses of the journey, the pilgrims usually carry with them small parcels of merchandise; by this means the produce and industry of Russia and the Caucasus, and even of Western Europe, finds its way up to the confines of Afghanistan, while the produce of Central Asia, in the shape of carpets, coarse cloth, felt, lamb skins, dried fruit, and precious stones, finds its way to the markets of Western Asia and Constantinople.

CINCHONA BARK FROM JAMAICA.

A large consignment of Cinchona bark from Jamaica has, during the past few months, found its way into the London market, where it has met with a ready sale, and at prices far in advance of those realised for Ceylon and East Indian bark. The results of the Jamaica Cinchona sales for the year 1879-80, have, according to the report of the Director of Public Gardens and Plantations, slightly exceeded the estimated returns, and are as follows:—Quantity of bark shipped, 27,[illegible] lbs.; gross amount realised, £5,380 9s. 6d., nett sum realised, £5,146 8s. 7d. It is shown in the report just referred to, that crown bark realises the highest price, and the greater value of this being established as against red bark, it is found desirable to plant the red bark only at elevations (2,000 to 4,000 feet) where the crown bark will not grow. The latter, however, may be cultivated in Jamaica over thousands of acres on the Blue Mountain slopes, on all elevations above 4,000 feet. The following quotations of prices will show the comparison between Ceylon and Jamaica barks. For red bark "fine quill," from Ceylon, reached a maximum of 4s. 3d. per lb., as against 4s., for "fair quill," from Jamaica. For "red root bark," the highest price for Jamaica produce was 4s. 8d. per lb., for "good root," as against 2s. 6d. for "good root," from Ceylon, thus showing an advantage in favour of Jamaica root bark to the extent of 2s. 2d. per lb. For "twig and small ordinary" bark of *Cinchona succirubra*, Ceylon produce obtained from 2½d. to 1s. per lb. as against 10½d. to 1s. 6d. per lb. for similar bark from Jamaica. "The above will, it is hoped, show that as with the celebrated Blue Mountain coffee of Jamaica, so with the Cinchona bark grown in the same region, the conditions of soil and climate appear to be eminently favourable to the production of the best qualities of these valuable products, and as large tracts of land and the necessary labour are now available, there are only wanting sufficient capital and energy to overcome the initial difficulties of the enterprise."

Accompanying the report from whence the above is extracted are a series of instructions under the title of "Hints and suggestions for raising Cinchona plants from seed and establishing Cinchona plantations."

CORRESPONDENCE.

MACTEAR'S MECHANICAL FURNACE, AND CONTINUOUS SYSTEM OF MANUFACTURING SULPHATE OF SODA.

Referring to the report of Mr. Mactear's paper and discussion thereon in the *Journal* of February 4, 1881, where our patents having been alluded to in a very disparaging manner, we rely upon your sense of fairness in permitting a few brief corrections to go forth to your readers through the same medium, viz.:—

1. We beg to point out that our first patent of 1875 is not restricted to any particular form of apparatus, but covers the principle of conducting the calcination and decomposition in the same vessel by mechanical means.

2. In this patent Mr. Mactear sees nothing but "failure." As a matter of fact, although now superseded by our improved pattern of 1880 date, there are from 25 to 30 furnaces, on the original plan, in regular operation, the returns from which continue to be satisfactory.

3. Mr. Mactear states that the "greatest objection of all to the system adopted by Jones and Walsh, and which holds good equally with the new form of furnace, is that the salt and acid, being all added within a comparatively small period of time, there is a great evolution of muriatic acid gas at the beginning of the operation, and a rapidly decreasing amount as the process continues." This objection is purely theoretical; in practice, it is found that with proper condensing arrangements, there is no difficulty whatever with the condensation, the fact being, as stated by Mr. Clapham, that more hydrochloric acid, and of a higher strength, is obtained from our patent furnace than from the ordinary hand furnaces.

4. There is nothing new in the "continuous system" adopted by Mr. Mactear. At the suggestion of Mr. Hugh Lee Pattinson, of Newcastle, it was tried in these works in 1876; the apparatus for the purpose was a "screw operated by a ratchet wheel," precisely as described by Mr. Mactear, and was provisionally protected by the engineer who made it. It was soon abandoned, but the apparatus is in our hands yet.

5. We deny that our rotating furnace (patent 1880) is in any respect an "imitation" of Mactear's carbonating furnace. It was merely a return to our original plan, tried in 1875, of which we have the model still. The principle of a rotating pan is old, much older than either Mr. Mactear's or our own ideas on the subject.

JONES & WALSH.

SUGGESTIONS FOR PREVENTING LONDON SMOKE.

In the second sentence of Mr. J. A. C. Hay's letter, he says, "I beg to be allowed to refute the statements in his (Mr. Scott-Moncrieff's) paper, in so far as they relate to the Royal Arsenal or any other of the Government gas works." He then proceeds to confirm my statements in every detail and particular. I alleged that, when in difficulties, the manager of the gas works at Woolwich Arsenal had used a short extraction. Mr. Hay confirms this statement. I alleged that the fuel resulting was superior. Mr. Hay confirms this by stating that the coal they used was volatile cannel, and that on a long extraction "it contained very little heating properties, and was not used under the retorts." Does Mr. Hay mean to say the fuel was worse under a short extraction than a long one? If so, he contradicts the statement made to me by Mr. Wallace, who said it was much better. Does Mr. Hay mean to deny that the best gas comes off during the first two or three hours? Does he deny that it comes off most rapidly during that period? In short, does Mr. Hay deny what he himself confirms, by his having "occasionally," and "in order to meet a few exceptional emergencies," adopted the scheme which I advocated in my paper? He speaks of the plan having been "found to be very expensive and uneconomical," but if Mr. Hay did not carry it out with sufficient intelligence, this is hardly to be wondered at.

With regard to Mr. Hay's postscript, as to whether Mr. Wallace did or did not supply me with the facts, this is a matter of personal veracity. I certainly understood him to state the facts precisely as I stated them in my paper, excluding any conclusions which I drew from them. This impression is confirmed by Mr. Hay's version of what has been going on at the Arsenal. I was quite unaware of any official relations between Mr. Wallace and Mr. Hay, nor, indeed, am I now aware what those relations are.

W. D. SCOTT-MONCRIEFF.

WOOD-CARVING.

With reference to the discussion which took place last night, I think it ought to be stated that the School of Wood-carving at the Royal Albert-hall derives its material support from some of the City Companies, and not from the Science and Art Department, as some of the audience seemed to imagine. I hope it will do good service to the trade, as well as to the public.

J. H. POLLEN.

11, Pembridge-crescent, W., Feb. 10, 1881.

GENERAL NOTES.

School of Art Wood-carving.—This school is now in connection with the City of Guilds of London Technical Institute. It is under the direction of a committee of management, of which Lieut.-Colonel J. F. D. Donnelly, R.E., is chairman. Day and evening classes are held in the school. The day classes are held from 10 to 5 on five days a week, and from 10 to 1 on Saturdays. The evening classes are held from 7 to 9 on four evenings a week, viz., Monday, Tuesday, Thursday, and Friday. The fees for day students are £2 a month, or £5 a quarter. The fees for evening students are 15s. a month, or £2 a quarter. There are at present 12 free studentships in the school, viz., six in day classes and six in the evening classes, the fees for which are paid from funds supplied by the City and Guilds of London Institute for the advancement of technical education. The holders of the studentships are selected by the committee of the school from persons of the industrial class, who are intending to earn their living by wood-carving. Candidates must have passed the 2nd grade art examination of the Science and Art Department in freehand drawing at least. Those who have some knowledge of wood-carving, or have passed in the other subjects of the 2nd grade art certificate, or in drawing from the antique and the figure, architectural drawing, or designing, or in modelling, will be preferred. There are now several vacant studentships, and there is also available accommodation for a few additional paying students. Students who have been in the school not less than twelve months may, on the recommendation of the inspector, receive such payment for their work as the committee may determine. By permission of the Lord President of the Council, students of the school have the privilege of free admission to the South Kensington Museum and libraries, on production of their school tickets. Wood-carving for the trade is undertaken by the school. For further information on all the above points, applications should be addressed to the secretary at the school.

Domestic Sanitation.—Dr. Richardson's course of nine lectures, to be delivered before the Ladies' Sanitary Association, in the Hall of the Society of Arts, will commence on Saturday, 12th inst., at 5.30 p.m., and be continued on successive Saturdays, until April 9. Tickets admitting to reserved seats, one guinea for the course, or 3s. 6d. for each lecture, can be obtained at the office of the Association, 22, Berners-street, W., or at the Society of Arts. Admission to unreserved sittings, 1s.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

FEBRUARY 16.—"The Participation of Labour in the Profits of Enterprise." By SEDLEY TAYLOR, M.A., late Fellow of Trinity College, Cambridge. W. H. HALL will preside.

FEBRUARY 23.—

MARCH 2.—"On Lighthouse Characteristics." By Sir WILLIAM THOMSON, LL.D., F.R.S. F. J. BRAMWELL, F.R.S., Chairman of Council, will preside.

MARCH 9.—

MARCH 16.—"Buying and Selling; its Nature and its Tools." By Prof. BONAMY PRICE, M.A. Lord ALFRED S. CHURCHILL will preside.

MARCH 23.—"The Increasing Number of Deaths from Explosions, with an Examination of the Causes." By CORNELIUS WALFORD.

MARCH 30.—"Recent Advances in Electric Lighting." By W. H. PREECE.

APRIL 6.—"The Manufacture of Glass for Decorative Purposes." By H. J. POWELL (Whitefriars Glass Works).

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at eight o'clock:—

FEBRUARY 22.—"The Languages of South Africa." By ROBERT N. CUST.

MARCH 15.—"The Loo Choo Islands." By Consul JOHN A. GUBBINS. Sir RUTHERFORD ALCOCK, K.C.B., will preside.

APRIL 5.—"Trade Relations between Great Britain and her Dependencies." By WILLIAM WESTGARTH.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings, at eight o'clock:—

FEBRUARY 24.—"Deep Sea Investigation, and the Apparatus used in it." By J. G. BUCHANAN, F.R.S.E., F.C.S. Captain Sir GEORGE S. NARES, R.N., K.C.B., F.R.S., will preside.

March 24.—"The Future Development of Electrical Appliances." By Prof. John Perry.

The meeting previously announced for April 7 will be held on May 12.

Indian Section.

Friday evenings, at eight o'clock:—

February 11.—"Gold in India." By Hyde Clarke. Sir William Robinson, K.C.S.I., will preside.

March 4.—"The Results of British Rule in India." By J. M. Maclean.

March 25.—"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Second Course will be on "Watchmaking," by Edward Rigg, M.A. Three Lectures.

Syllabus of the Course.

Lecture II.—February 14.

The ordinary watch—Degree of accuracy required in it—Systems of manufacture in this country and abroad—Description of specimens illustrative of the various stages of construction—Comparison of the several systems.

Lecture III.—February 21.

Necessity of efforts to promote the art in this country—Need of education, theoretical and practical, in horology—Literature—Great want of uniformity in gauges, screws, &c.—Exhibition of ordinary and complicated watches, and of watchmakers' tools—Conclusion.

The Lectures will be illustrated by Specimens, Models, and Diagrams. The different movements, &c., will be shown enlarged on the screen by means of the Aphengiscope and the Electric Light.

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

March 7, 14, 21, 28.

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Three Lectures.

April 25; May 2, 9.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

May 16, 23, 30.

Admission to Meetings.

Members have the right of attending all the Society's meetings and lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 14th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Edward Rigg, "Watchmaking." (Lecture II.)
Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. Hueffer, "The Troubadours." (Lecture V.)
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. William M. Crocker, "Geographical and Physical Aspects of Sarawak and North Borneo."
British Architects, 9, Conduit-street, W., 8 p.m. Adjourned Discussion on Mr. E. C. Robins' paper, "Sanitary Science in its Relation to Civil Architecture."
Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Sir John Lubbock, "Fruit and Seeds."

Tuesday, Feb. 15th...Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. A. Schäfer, "The Blood." (Lecture V.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion upon the papers by Messrs. Colson and Meyer, "The Portsmouth Dockyard Extension Works."
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m.
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m. 1. The Secretary, "Additions to the Society's Menagerie during the Month of January, 1881." 2. Mr. C. O. Waterhouse, "The Coleopterous Insects Belonging to the Family *Hispidæ*, collected by Mr. Buckley in Ecuador." 3. Mr. W. L Distant, "Additions to the Rhyncotal Fauna of the Ethiopian Region." 4. Mr. Edgar A. Smith, "A Collection of Shells from Lakes Tanganyika and Nyassa and Other Localities in East Africa."

Wednesday, Feb. 16th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. Sedley Taylor, "The Participation of Labour in the Profits of Enterprise."
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Charles Greaves, "Relative Humidity." 2. Mr. William Marriott, "The Frost of January, 1881, over the British Isles."
Institute of Bankers (at the Theatre of the London Institution, Finsbury-circus. E.C.), 6 p.m. Mr. Arthur Ellis, "The Clearing System Applied to Trade and Distribution."
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. F. Brent, "Prehistoric Interment at Plymouth." 2. Mr. C. Watkins, "Roman Wall of London in Houndsditch." 3. Mr. J. Romilly Allen, "Notes on New Grange."

Thursday, Feb. 17th...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Dr. Francis Day, "British Fishes." 2. Mr. C. B. Clarke, "Right and Left-hand Contortion of the Corolla." 3. Prof. P. M. Duncan, "A New Form of Sponge." 4. Mr. Samuel G. Shattock, "The Reparative Processes which occur in Vegetable Tissues."
Chemical, Burlington-house, W., 8 p.m. 1. Ballot for Election of Fellows. 2. Mr. D. Tommasi, "A New Apparatus for showing the Dissociation of Ammonium Salts." Mr. M. W. Williams, "The Estimation of Organic Carbon and Nitrogen in Water Analysis, simultaneously with the Estimation of Nitric Acid."
London Institution, Finsbury-circus, E.C., 7 p.m. Rev. H. R. Haweis, "Violins."
Royal Institution, Albemarle-street, 9 p.m. Prof. Pauer, "History of Drawing-room Music." (Lecture I.) With Musical Illustrations.
Royal Historical, 22, Albemarle-street, W., 8 p.m. 1. Mr. Henry E. Malden, "The Battle of Ockley between Ethelwulf and the Danes in A.D. 851." 2. Mr. Frederick G. Fleay, "The Connection between History and Allegory in certain Poems by Chaucer."
Numismatic, 4, St. Martin's-place, W., 7 p.m.
Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. A. F. E. Grant, "Water-bearing Strata of the Thames Basin."

Friday, Feb. 18th...Geological, Burlington-house, W., 1 p.m. Annual Meeting.
Royal United Service Institution, Whitehall-yard, 3 p.m. Mr. E. Delmar Morgan, "His recent visit to Kuldja, and on the Russo-Chinese Frontier."
Royal Institution, Albemarle-street, W., 3 p.m. Sir John Lubbock, "Fruits and Seeds."
Philological, University College, W.C., 8 p.m. Mr. H. Sweet, "Pronunciation of Welsh." (Part I.)

Saturday, Feb. 19th...Ladies' Sanitary Association (at the House of the Society of Arts), 5.30 p.m. Dr. B. W. Richardson, "Domestic Sanitation or Health at Home." (Lecture II.)
Royal Institution, Albemarle-street, W., 3 p.m Mr. R. Stuart Poole, "Ancient Egypt in its Comparative Relations" (Lecture I.)

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, FEBRUARY 18, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The second lecture of the second course was delivered on Monday, 14th inst., by Edward Rigg, M.A., on "Watchmaking." The points to which attention was specially drawn, were the degree of accuracy required in the ordinary watch, the system of manufacture in this country and abroad, and a comparison of the several systems. The lecture was illustrated by the use of the aphengiscope and the electric light, which enabled different parts of watches, and the works of several watches (going and not going) to be reflected on a screen. The audience were thus able to see the actual object itself on an enlarged scale. Next week, it is intended to show the action of repeating and other watches in the same manner.

The collection of specimens illustrative of the various stages of construction in the watch, which were exhibited, will remain in the rooms of the Society for a week, and can be seen by anyone interested in the subject, on presentation of his card.

The lectures will be published in the *Journal* during the summer vacation.

LABEL FOR PLANTS.

The Council are prepared to award a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary not later than the 1st May, 1881.

The Council reserve to themselves the right of withholding the Medal and Prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

ADJOURNMENT OF MEETING.

At the meeting of Wednesday, the 17th inst., the discussion on Mr. Sedley Taylor's paper, "The Participation of Labour in the Profits of Enterprise," was adjourned to Friday, the 25th inst., at 8 p.m. Cards already issued will be available for the adjourned meeting.

DOMESTIC ECONOMY.

1. The Council will hold a Third Congress on Domestic Economy, at the Society's Rooms in the Adelphi, London, during the present year.

2. The Council offer Seven Bronze Medals, and Certificates of Merit for Papers (not exceeding 1,000 words), written by Teachers of Public Elementary Schools and Training Colleges, which shall give an account of the best method practised by the teacher, of the teacher's experience, and the result of the teaching, in any one or more of the seven classes of subjects named below.

3. The Education Department, in the Code of 1880 (p. 31), classes the following subjects under Domestic Economy for Girls:—

The First Branch includes—

(*a*) Clothing and Washing.
(*b*) The Dwelling—Warming, Cleaning, and Ventilation.
(*c*) Rules for Health—The Management of the Sick Room, Cottage Income, Expenditure, and Savings.

The Second Branch includes—

(*a*) Food—Its Composition and its Nutritive Value
(*b*) Food—Its Functions.
(*c*) Food—Its Preparation and Culinary Treatment (*i.e.*, Practical Cookery) (§ 24).

The Council have resolved to add the subject of Needlework, which will be exhibited and discussed in the Congress, although it is not classed in the Code as a branch of Domestic Economy.

4. Only one medal will be given to a teacher, but the subjects taught successfully will be inscribed on the one medal and a certificate given.

5. The papers must be sent to the Secretary of the Society of Arts by the 1st May next. Each paper must be enclosed in a sealed envelope, bearing a motto, and must be accompanied by an envelope bearing the same motto, and having within it the writer's name and address.

6. No medals or certificates will be awarded if the papers are not of sufficient merit to deserve them.

INDIAN SECTION.

Friday, February 11, 1881; Sir William Rose Robinson, K.C.S.I., in the chair.

The paper read was—

GOLD IN INDIA.

By Hyde Clarke.

I. It was originally intended that this paper should have been read before a general meeting of the Society, in which case it might have been treated in considerable detail, for popular explanation. This, however, is not suited for the audience of the Indian Section, acquainted to a great extent with the subject, and whose attention has already been called to its bearings. If, however, the mode of treatment be altered, the importance of the subject is none the less, if it be not indeed greater. It is of much moment to all interested in India to determine what is the real character of the gold formations, and what effect they are likely to have on the country.

In so dealing with the matter in its general relations, there will be this advantage, that the possibility of promoting any individual speculation will be eliminated.

That there will be speculation, and wild speculation, in the new undertakings, there is not room for any doubt, but that is not to be taken into account in the serious consideration. It is not the casualties, not the extraneous circumstances, which are to be mainly regarded, but the really essential conditions.

There is a prevalent sentiment in Indian circles, that it is necessary to be cautious in dealing with the gold question. It is necessary to be cautious and to be prudent, but then the application of this principle has to be guarded. If it be considered desirable to avoid fallacious hopes, and to discourage undue excitement and gambling, it is none the less desirable, on the other side, to be cautious and to be prudent, so as not to impede or discourage the legitimate development of any resource of our Indian empire; particularly this, for gold is greater than indigo, than tea, than cinchona. This is a right side of prudence, for if we take a false step, then in this case, as in so many others, we shall throw back for years the advancement of the population. It was such hesitation which postponed the commencement of the railway system in India, and which has deprived the country, even to this day, of its full benefits, and such examples can be multiplied.

It appears to the public, that the discovery of gold in India is indeed one of the most remarkable events in this age, which has seen so many events materially affecting the destinies of the human race. The re-discovery of gold in California, and its discovery in Australia, greatly as they acted on the enterprise of the world, yet as the operations in connection with them took place in countries thinly peopled, they did not have the direct influence which must result from the development of gold mining amidst populations numbered by hundreds of millions.

In the same way as the existence of gold in India is regarded as a new fact, so is the extent of the formations regarded by many with doubt. It is beyond the power of any one to determine the profitableness of the new workings, or the precise manner in which the condition of India will be modified, but the careful observer cannot fail to ascertain from history that the antecedent circumstances are such as to give importance to the character of the present development. This is what we have now to take into account, not actual results, not possible loss, but the real gravity of the explorations, so that we may neither exaggerate our expectations, nor neglect by carelessness what may be fairly esteemed to be of possible value to the empire.

The gold of India is traditional,* and yet, in our days, gold had become scarce in those regions. There is reason to think that the poetical legends of a golden age are not without foundation, and that they refer to a time when the river sands of the world and the alluvial formations were worked for this metal, which furnished the hoards of the kings of old.† This golden age was followed, as the archæologists agree with the poets, by a bronze or brazen age, and then came the iron industry, giving name to the iron age.

Wherever we look we find that the rivers have been cleared of the accessible gold, and we find evidence of very old workings. India affords the same testimony. In ancient times its countries must have been the richest, for, besides its wide area, it has numerous rivers, in most of which gold is still found, but of such poor yield as to be scarcely worth working, even where the rates of wages are so nominally low.

There is scarcely a river in India but gives evidence of the wide diffusion of gold, though the rise in wages has reduced the extent of local working from what it was 40 or 50 years ago. In the Indus, between Attock and Kalabagh, as much as 2,000 oz. yearly used formerly to be got. Gold is found in the basin of the Ganges, in the Goomty, the Ramgunga, and other rivers, particularly those running at the foot of the Himalayas.‡ Hence many are now inclined to look with interest on possible discoveries in those regions. In Southern India, there can be little doubt that the known sites in the Wynaad and Mysore are only indications of larger formations. River washings are numerous in the Assam provinces, and it has even been estimated that, at one time, the yield was near 40,000 oz.

While the numerous ancient workings are admitted as acknowledged evidence of former yield, yet they constitute with many a chief element of doubt, because it is considered the cessation of working is an indication of present worthlessness.

Ancient workings are found in many parts of the world, as in Spain largely, and in this country to a more limited extent. Thus, we are able to form some idea of the influences which may interfere with operations. The interruptions are not necessarily dependent on failure of ore, for mines which have been abandoned for centuries

* On the possible connection of South India with Ophir of the Bible, see an interesting letter, by Mr. F. H. Crozier, in the *Mining Journal*. Mr. Samuel Jennings has dealt with the same subject, but the reference has escaped me.

† See my book, "Khita and Khita-Pesruvian." (Trübner and Co.).

‡ "Notes on the Distribution of Gold." James Wyld, Charing-cross. Pp. 26 and 27.

are resumed and kept in a state of production for long periods. Political and social events greatly affect these results. At former epochs mines were largely worked with convict or slave labour, and at other times with serf labour.

A war, or an invasion, as that of the Mohammedans, would stop slave labour, and likewise affect the continuance of the skilled labour necessary for supervision. The stoppage of mining of itself constitutes an obstacle to resumption; so in the case of arable lands, the abandonment of cultivation brings its own evils and impediments. Wood covers the open country, and wild beasts find shelter, while the water-courses are interrupted, and marshes are formed, with fever as an attendant consequence. In abandoned mines, the shafts, pits, and galleries fall in, timber rots, and water accumulates. By and by the knowledge of the productive parts is forgotten, and workmen having left the district, the local traditions are lost.

Mines were, besides, worked by what has been here termed serf labour. The resident population were compelled to contribute labour for the mines, and those beyond to cut and transport wood for timbering and fuel, or to find carts and beasts to convey supplies and produce to and fro. Such tributary labour is compensated by nominal wages, by remission of taxation, or by exemption from military service. If, however, the population is interfered with by civil or foreign war, or is released from the strong hand of despotism, then the whole system is relaxed, the technical training disappears, there is an indisposition for mining employment, and it becomes very difficult to restore the former regulations and restrictions.

Thus in Asia Minor, for instance, the relatively rich silver and copper mines were kept working with difficulty, and many were abandoned. The Tokat copper mines and the silver mines of the Gumush Khaneh were kept going by exceptional richness, but at length the Ottoman Government hesitated as to the economical value of the traditional system. What was gained in copper and silver was considered to be lost in taxes and service, and the mines have consequently been sold.

The condition of mining is generally artificial. The public form their estimate from some places of exceptionally rich product, but mining generally is a business of poor and uncertain returns, as precarious as the fisheries; many a mine in the world must cost more than twenty shillings for its pound's worth of produce. The operations are often carried on as a gamble by those who contribute capital, equally by those who contribute labour on share or tribute. Whaling and sealing encounter the same vicissitudes. Not even agriculture is so closely worked as such operations. Everything in the shape of mineral is tried and raised at a loss, without profit or with profit; a slight decline in market price will throw the poorest mines out of work, and a small rise causes them to be opened. Then, differently from agriculture and from fishing, the product of mining is put in abeyance, and suspended even for many years, until a return of partial or greater prosperity. The farmer goes on growing something in the famine years, but the miner stays his hand. He is always, to some degree, migratory, and he can turn to other employments.

Thus, in a career of such vicissitudes, there are recurrent epochs, in which every shaft is fruitless, and the condition of the Indian gold mines is not exceptional. Their abandonment in no degree shows they cannot pay; it is no argument against their resumption, and none in favour. The value of the Indian mines must be determined by conditions altogether apart from such facts. The facts are in favour of the general existence of gold formations, and, considered in this light, they are of great importance, for they bear testimony to an extent of formations, illustrative of former enterprise, and inviting present consideration.

The condition of the old workings is very well described by a gentlemen of authority, Mr. Samuel Jennings, F.L.S., F.R.G.S.* He says, the native system consisted in the sinking of perpendicular shafts on the reefs and other workings around the base of the shaft, so long as it was safe, and working the alluvial deposits on the sides of the hills, so long as the dry weather continued; but as soon as the heavy rains of the season set in, work became impossible, and, as has happened recently, the rain has destroyed the excavations, by choking them up with the debris and earth that had been loosened, and the whole operation had to commenced again anew. Thus, in process of time, the entire surface, to the depth of 20 to 30 feet, was completely turned over, and all the precious metal extracted. The same state is found in the West African workings. The idea, says Mr. Jennings, of protecting their shafts by timbering, does not appear to have occurred to the native miners, whose powers of penetration seem to have been limited to the extent they were able to excavate in a single season.

In my opinion, there must, however, have been more able mining by the older races. An adit, 126 feet in length, on the Kintail estate, seen by Mr. Brough Smyth, is a type of this class. There must have been in ancient India the identical workings of the old miners, of which we have such fine specimens of Roman and earlier times in Spain and Britain.

Although gold production, under an energetic despot, may have been carried on with good results, a small despot or chief would not be equally successful in the attempt; on the contrary, he would find every obstacle. He would have to obtain assistance from without, and train workmen for the extraction and the reduction. Thus, it is not at all surprising that the recent representation of the ancient wealth was found in the gold washing of the Kurumbar. We must hesitate to take minimum results of Kurumbar efforts as any measure of what is to be achieved under operations, by machinery, quite beyond the compass of simple gold washing.

In South and Central America, in many cases where regular mining had ceased, the Indians would, by a few days of river washing, get such a small quantity of gold as was required for their new purchases of goods from the traders. On this head some misconceptions prevail, for it is supposed that the gold washing is not kept up for some mysterious reason. The real reason of the casual production is, that the Indian is not by pursuit a gold washer, his food is obtained by other means, and the gold is sought as a special commodity, for

* *Herapath's Journal*, Dec. 4, 1880, p. 1881.

a special use. Gold washing, too, is not a favoured employment in most parts of the world, but one that is irksome, and is only carried out on a large or continuous scale by compulsion.

Nothing can be a better testimony of the neglect of a gold district than its falling into the hands of the native washers, who have only the simplest apparatus. The most inconsiderable application of better expedients, as of a cradle, alters the whole arrangements, and is attended with commercial results. The native gold washer can get through but little material, and, even when most expert, in some districts, sends into the current much of the gold.

Political events, as has been said, must have exercised the greatest influence on the alternations of gold raising in India. When we look back and consider the previous events, which have so affected the regions now attracting interest, we shall be able to allow or others far remote, or unknown to us. While gold, when accumulated, dazzles the imagination, we do not conceive the precarious course by which these accumulations have been brought together, and that, so far from its being in the nature of things that the collection of the metal should be constant and never be interrupted, it can only take place under very favourable circumstances.

In the early stages of discovery, it is very difficult to arrive even at an approximation to the yield. The assays can only be those of casual specimens, giving no real estimate of the result. An assay must depend on the sampling, and though this can be effected with a poorer ore like copper and lead, it is difficult with gold where a very rich metal is widely disseminated.

Even where assays are applied in a practicable way in gold mines, there is often a large difference between the assay and the practical yield, even when the tailings are assayed. Gold, from its nature, can be distributed in such minute fragments that it is not mechanically secured, but remains in the stuff, or is floated away. In a mine so productive as that of the St. John del Rey Company, in the Brazils, which has given dividends for above half a century, the best estimate is that the recovery of gold has only been from 70 to 73 per cent., leaving from 27 to 30 per cent. for possible loss, as the processes applied to the remaining material are successful only to a small extent. The only possible estimate to be formed is from the whole yield of a mine like the St. John del Rey, and then a large deduction must be made for possible loss of metal. For gold working there must be gold on the spot, but even then the commercial realisation is not secured. There is gold enough in the world, the existence of which is ascertained, but which is not extracted. This is the case in Central America, in Colombia, in Venezuela, in Peru, in Bolivia, in Brazil, in Africa, and, indeed, throughout the whole world. If the place has not facilities of access, if there is no good supply of suitable labour, and, above all, if there is not sufficient water, the mineral remains unworked.

If the mines must be worked and drained by powerful machinery, it may be impossible to place such on the spot, for want of roads suitable for conveyance. Even if machinery can be placed, it may be of no use for want of fuel, or for want of water-power. Thus a variety of conditions have to be regarded in forming any opinion of the real value of any district.

On account of the small quantity of metal in gold stuff, large quantities of material must be pounded in order to get it into a state for reduction. Thus, generally, water is an essential for all gold operations, unless the metal exists to such an extent, that the ore can be conveyed to another place for reduction. Where such is not the condition, the mines remain unworked in some fine climates, and where there is known to be ore enough.

II. So far as Indian gold is concerned, the districts now under consideration are in a hill region, subject to a very heavy rainfall. This is carried off by streams, and in some parts will not be available, and cannot be pounded or secured by bends. There are, however, estates where streams, and in other districts storage, are available for water. In fact, India in these respects has advantages equal to most portions of the Californian regions, and beyond Australia. There are few parts of New Zealand better provided, nor are there in Brazil.

Thus, where an estate has a good reef on it, and the water well laid on, the prospects may be looked upon as hopeful. Still, there will be vicissitudes, a season of short rainfall, the bursting of dams, and various incidents, which may interrupt steady working.

Calculations are put forward that a large and inordinate amount of capital is already invested in Indian mines, but it is quite idle to give such figures. The greater part of the amount subscribed being for the purchase of estates having gold formations, constitutes a mere transfer, and the country is neither richer nor poorer, however individual wealth may be affected, and the condition of one person or another. The true apportionment of capital is for the export of machinery, and for the remittance of wages for workmen.

The truth is, so far from a large amount of capital being provided, it will be found in more than one case that the capital is insufficient. Whenever too large a proportion has been applied for purchase money, the working will be starved, and even a good mine may prove unremunerative. In such cases, the first capital being exhausted, the original holders may have to submit to a total loss, while the next comer may get a large return on a very small investment. These are the contingencies of mining, and the large prizes draw people into these operations. It is the last purchaser who obtains the whole return for all the capital which has been sunk in the concern.

The fact is, the absorption of capital will be, to a great degree, self-regulating. Only a limited amount of capital can, in 1881, be applied to opening out, to working and to machinery, the same in 1882, and in 1883 very little capital will be applied, unless some return has been seen. It will be found that so-called gold lands cannot be sold for fabulous high prices, any more than for nominal low prices.

A real loss of capital will be incurred by injudicious provision of machinery. Wherever too large a quantity of machinery has been sent out, not for mining requirements, but to produce an effect on the Stock Exchange, and to run up the shares, a

heavy loss may be looked for. Whenever a mine goes out of working, although the machinery may be good and in fair order, it seldom fetches its price, as the removal of machinery is very difficult. Then, when machinery is kept too long, during a depression, it likewise deteriorates, and may be reduced to old iron.

From the real investment of capital in India, notwithstanding much loss, a fair return to this country may be expected. Machinery makes a market for other machinery, and so does the supply of engineering workmen to a country. With a large number of such men attached to the mines, it may become possible to introduce and use other machinery not otherwise available. The expenditure for wages is not likely to be excessive; it will check itself, as, when found unremunerative, it will be stopped. Even the large salaries of superintendents and skilled officers cannot be a total loss to us, as many of these men will remain, and open up other enterprises. A very good example of this is given in the *St. James's Gazette* of this evening. In consequence of the increase of machinery in the Linares lead district of Spain, the olive growers have taken to the purchase of improved machinery, instead of the old wooden oil presses. It will be noted that the Belgian manufacturers, having got into the district, obtained the benefit of this new business.

Although rather a speculative mode of regarding that and other such operations, it is a true one that, whatever the direct result, there must be a gain from introducing into India Englishmen of intelligence and enterprise. Such considerations are entitled to particular weight, when we come to regard the national relations of such undertakings. It may be said, indeed, we are hedged against loss in a material point of view. It is in this respect that England in the long run is found not to have been a loser in the many disastrous ventures in gold mines of fifty years ago. The internal losses were very painful to many over-speculative persons, but, in the event, the country was no loser. Although there was some loss in Brazilian mines, yet others gave a return, and in the end we have got a hold on the produce of Brazil, which has in all kinds of ways been a benefit to us.

In fact, it is from no single set of figures that the real influence and value of such operations can be determined, and they must be examined as a whole, and in their full results, with all their losses and all their gains. These the balance-sheet of a mining company will not disclose, as it will not show the effective distribution of capital. There may be loss to the shareholders, and gain to the manufacturer and the merchant.

A very important consideration is the supply of labour. The want or failure of this has put a stop to mineral industry in many countries. Thus, in Brazil, in the Portuguese times, the numerous and productive mines of the auriferous districts depended on slave labour. With the emancipation of the negroes whole districts were thrown out of yield, and it is only by close attention that labour has been obtained for the St. John del Rey mines, and the large dividends have been kept up. The supply of labour must be free and continuous, and consist of men who are disposed to engage in such a product. This is the strength of Chile, where the natives are content to undergo the drudgery, and receive regular wages, or, as tributers, run their chance of the prizes of rich and casual finds.

It is likewise necessary to have English or other foreign miners who understand the business, and are willing to go abroad, and encounter, with or without their families, the vicissitudes of distant travel. So far as this population is concerned, we have it at home in Cornwall and Wales, whence many proceed, not only to English countries in Australia, South Africa, Canada, and the United States, but to foreign lands. They are as familiar with the hot climates of Brazil, Chile, and Mexico, as with any of the regions they frequent. Then there are our Australians. There would, consequently, be no difficulty in obtaining a supply of workmen for our Indian empire, where they are under English protection. The same circumstance will favour, in case of need, the introduction of foreign miners. The mass of the labour, however, will be local.

Our own people are well acquainted with gold mining in Australia, New Zealand, California, Brazil, and Columbia, and it is not a business that they have to learn, but one in which they have been largely engaged. Much, too, depends on the enterprise of such men, for many classes of working can only be carried on by the participation of such men as sharers or tributers, one of the forms of mining enterprise which distinguishes it from most branches of industry. It is, too, an inducement which brings in labour and intelligence, as well as capital; and mining depends, not solely on the capitalist, but, in many cases, largely on the co-operation of the working men, who share the risks as well as the profits. Thus, the risk of the capitalist is sometimes reduced; but, at all events, something more than the efforts of the capitalist is brought to bear, and so it will be in India, where the individual labour will be stimulated by an incentive beyond the wages of labour.

III. Apart from any operation on the coinage of India, and on the exchanges, it is to be expected that a much more important influence will be effected on local prices of wages and commodities. Looking at these from an English point of view, it has been too much the custom to consider them as dependent on English conditions. There is, however, very little contact between what may be called the English system of prices, and the Indian system of prices.

The contact is effected by the export from India to England of sugar, coffee, rice, cotton, jute &c., the prices of which for export are determined by the London or European market prices. This, however, exercises very little influence on the main bulk of the agricultural crops of India.

Far different are the relations between England and the countries on the adjoining seas, Ireland to the west, and the shores to the east and south. Every pound of meat, every fowl, every egg, each pound of butter, and all fresh vegetables or fresh fruits, are liable to be taken up for the great markets of London and Paris, the prices of which, with the cost of transport, govern those of the outlying districts. Hence, the general complaints of the growing dearness of living in the large and small towns, and which tends not to a levelling of prices in the proper sense, but to an augmentation of prices to the higher standard.

Within each region, the completeness of railway

transit contributes to such results, and the seas are bridged by steam transport, also penetrating the rivers. The prices of food affect the prices of labour to a considerable extent, and modify the operation of other causes. The Irish labourer, who, half a century ago, received 4d. to 6d. per day, or Indian wages, now receives 2s. or more.

In India, as has been pointed out by me, in common with others, similar results have, of late years, been seen in operation, but they have not reached their full development, and must, therefore, continue until it has been attained. This is the point to which the attention of economists must be turned, because the quicker or slower rate of this development means the earlier or later attainment of an advanced condition by the population of India, and the consequent rate of public revenue.

So long as the great disparity of rate of prices between India and England exists, there must be a disturbance of all economical relations. There must be a really abnormal relation of imports and exports, an abnormal disproportion between the amount remitted to England and the rest of the revenue of India, a false relation between the supply of capital to India and its returns.

Taking this last head alone, India labours under great disadvantages as compared with many other countries. If a railway be made, say in the United States, with English capital, then the returns can be calculated upon at something like English prices. In India this is not so; the railway iron and machinery shipped from England is of the same identical cost, but the carriage of commodities and of passengers has to be underken on a scale wholly different. No question arises elsewhere, for instance, as to the carriage of passengers at 2 pice per mile. In some countries it is possible to charge an anna or two, as here at home.

That, in many classes of enterprise, where the amount of traffic, or transport, or commodities dealt with in India would, at what may be called normal rates, produce a good return, in India they give an insufficient money yield, the undertaking becomes impossible with profit, or without a guarantee burdensome to the Government, and the abundant capital of the European markets is not applied to India, while it is freely available for alien countries, which have no claim on English sympathies, in Brazil or in Chile.

It is the rise of prices now going on in India, and already referred to, which will act independently and concurrently to affect the situation, and dominate the commercial and financial conditions. It is, therefore, perfectly futile to talk of the application of great economical laws, when we neglect the circumstances on which their operation depends.

The development of gold working means the development of English knowledge and enterprise, and the consequent progress of India. Then the railway system will no longer be stinted, and the correspondent benefits will be obtained. Many a commodity will rate locally at a higher price in consequence of higher wages, but the efficiency of railway transport, as compared with the bullock cart, will place the commodity at the port, under commercial conditions. Many commodities, which now cannot be moved and are excluded from trade, will, under quick transport, become exchangeable articles of commerce. If these results were only to be regarded as possible or probable, the whole subject of the gold fields would be worthy of the gravest consideration, and as one not to be dismissed on doubts, or on the absence as yet of ascertained realisation.

Nothing, indeed, is more familiar to the old Indian statesman and resident than the alteration and rise of wages and prices which have come home to him in his own time, a rise which has been continuous, and the conditions of which we know will never be reversed. Even in the Wynaad this has been as striking as anywhere else. In 1833, rice was 20 to 30 seers to the rupee, and a sheep, even at Ootacamund, 12 to 16 annas. In 1833, the wages of labour were 2 annas 6 pice per day, but the earnings of a Kurumbar gold washer were only estimated at 2 annas per working day.

In 1876, the Prince of Wales's Company paid from 4 to 5 annas a day, and it may be noted that in Australia the wages are more shillings than annas, being from 6s. to 8s. per day.

This rise of prices, which strikes everyone, is recorded by Sir Richard Temple as a general fact affecting India, and is, in this respect, brought forward as a topic in his "India in 1880."

The time must come with the working of the gold regions of India, that the wages will be practically the same in Wynaad as in Victoria, and this will not impede the gold workings, because, in Victoria, the poorest stuff is raised to a profit with high wages and high-priced food.

IV. It is difficult, in any reasonable compass, to giv a fair idea of the extent of the gold regions of India, or to effect this by either historical or topographical treatment. If at the present moment the Wynaad regions concentrate attention on them, they cannot be regarded in any general consideration as entitled to sole notice. Other districts in ancient times were better known, and there are mineral formations in outlying regions which, on examination, may prove to be productive, and which may give unexpected value to countries now regarded as undeserving of attention.

On this occasion, we must direct our notice to Wynaad and the neighbouring lands. These must certainly be considered as an old and recognised gold district, at whatever opinion we may have arrived as to its practical utility. The old workings attest its former and continuous occupation for mining, while the petty operations of the native gold seekers preserve the tradition, rather than prove, the extent or importance of the formations. More than once, in later times, attention has been directed to the possibility of turning these indications to account, and that chiefly in dependence on the historical indications. The earliest historical evidence, however, that we as yet possess, is that brought forward by the eminent authority on the archæology of India, Dr. Burnell, quoted by Mr. Eastwick and Mr. Brough Smyth. In his note on the Great Temple of Shiva, at Tanjore, he is of opinion that it could only be by gold treasures that the Rajahs of Southern India could raise in the eleventh century the great temples to Shiva, and in the twelfth and thirteenth centuries those to Vishnu. Were there nothing else to support it, this conjecture would fall to the ground, because the temples were not really constructed with gold, but with labour, like the pyramids of Egypt, unless

labour or food had been imported from without, and paid for with gold. Any gold expended within the country would, under most circumstances, remain within it, and be again collected into the treasury. Dr. Burnell, however, brings direct proof as to the abundance of gold, by his successful decipherment of a remarkable inscription in the Tanjore Temple. Dr. Burnell is thus enabled to state that in the eleventh century gold was still the most common precious metal in India, and stupendous quantities of it are mentioned. He, too, considers that this gold was obtained from mines, and that the Moslem invasions interrupted their workings. This is the opinion which appears best to account for the facts known to us.

Mr. Edward B. Eastwick, with his accustomed power of research in Oriental history* has treated of the historical data. He records that, in 1923, Allâhu'd-din took the City of Deogarh, and ransacked the citadel, receiving besides 175 lbs. of pearls, 50 lbs. of diamonds, and 25,000 lbs. of silver, as much as 15,000 lbs. of gold. Although this is supposed to be an exaggeration, there is no reason to deal with it as other than the actual conditions of the treaty made and recorded, though the value of the gold would be some £600,000 sterling. Such a treasure is by no means unexampled in history. Indeed, the accumulation of treasure was as great a political end as was the increase of territory, and each conqueror possessed himself of the accumulated stores of his victims.

Tippoo Sultan possessed great quantities of gold. In Maxwell's "Life of Wellington," it is stated that he was to pay to Lord Cornwallis, under treaty, three crores and thirty lakhs of rupees in gold mohurs, pagodas, and bullion, equal to about £3,300,000.† On one occasion, Tippoo sent thirty-eight camel loads of money to Scindiah, to buy him over as an ally. By the estimate of treasure and property taken at Seringapatam in 1799, it is clear that Tippoo had been able to make fresh accumulations of specie; there were 16,740,350 star pagodas. His throne had, at least, £30,000 worth of gold in it. Besides this, he had paid large sums abroad for war supplies and political purposes.

Whether this gold was obtained from the mines of Southern India is uncertain, though the Commissioners, in 1833, state, "it is pretty certain that Tippoo attempted to make them a source of revenue during his possession of the country" which was included in his dominions. Indeed, all the English inquiries turned on this point of the known existence of the metal. In 1792 and 1793, a joint Commission, from Bengal and Bombay, was appointed to examine the state and condition of the province of Malabar. The Commissioners refer, briefly, to the occurrence of gold, in treating of the subject of the royalties claimed by the rajahs, which is stated to be on "all gold ore," and also of "compositions of gold," which were found in the Nilambur district.

In 1793, Mr. Duncan, Governor of Bombay, formed a strong opinion of the value of the mines, and took some steps to ascertain the extent of them. In 1802-3, the auriferous rocks of the Nilambur valley are again mentioned, and, in 1813, a work was published by Dr. Whitelow Ainslie, in which an account was given of the localities where gold is found in India. He says, "Gold dust has been found in the bed of the Godâveri, and in Malabar in the bed of the river, which passes Nilambur in Irnaad district. It has, moreover, been procured in very small quantities in Wynaad, in the Arcot district, and in the sand of Beypore river, near Calicut. Though the sources are evidently numerous from which this valuable metal can be obtained in the Indian peninsula, it would seem, from the little interest they have hitherto excited, that none of them promised to be very productive."

It must not be argued that the Indian authorities were so very remiss, for, apart from political disturbances, which attracted the attention of the authorities, there was no school of gold-mining in England. Such existed in Germany only, and the subject could, in England, be studied from books alone in a most imperfect manner. It was only at a later time that Englishmen were employed in gold mining and reduction in America and became conversant with it. It was not, however, until the Australian discoveries that we obtained a large and organised school within our own empire, which now justly holds a high rank. Indeed, the Spanish, German, and Russian schools are now connected with smaller operations, while the English and American schools are supported by practical works on a much larger scale. It is also by these schools that the application of machinery has been carried out, beyond the examples of the other and older branches of professional mining.

While this state of affairs accounts, to a great degree, for the assumed neglect of the Indian formations, it also accounts for the failures in the next epoch, when the Indian authorities more seriously and more earnestly turned their attention to their gold resources. Before the year 1831, Mr. William Sheffield, the principal Collector in Malabar, had been buying gold for the Government, and on the 10th January, 1831, he sent in a report on the several localities where gold was known to be found, and on the methods of mining employed by the natives.* Mr. Sheffield made such an impression that Lieut. W. Nicholson, 49th Regt., N.I., was appointed by the Government to search for gold "in the mountains on the Malabar coast," and with him was associated Mr. Henry Louis Huguenin, a Swiss, as to whose qualifications we have no information. It may be mentioned that Lieutenant Balfour, R.A. (now Gen. Sir G. Balfour), being at Cobar in 1835, noticed that his servants washed gold there. Every resident told him of gold. Such facts were of constant observation.

It will serve to show what erroneous and exaggerated ideas prevailed, that Mr. Huguenin stipulated with the Government that he was to have one half of the gold he might assist in finding and reducing during a period of twelve months, and the same proportion of all gold he might collect from the mountain streams, &c., by washing; the government having the right to take such share of the produce at the market price of gold.

Had the Government, or its conductors, had the advantage of experience elsewhere, they would have known such conditions were impracticable.

* See "A Hand-book for India;" John Murray. Article in "Gentleman's Magazine." Letter to the *Times*, 2nd Jan., 1879. Quotations from the same in "The Report on the Gold Mines of Wynaad." By R. Brough Smith, London, 1880.

† See authorities already quoted.

* All this is derived from the sources previously quoted.

All the greed of the Governments of Spain and Portugal had resulted in their accepting a small tax or royalty in Mexico, Peru, or Brazil, although they might retain their monopoly of mintage or purchase. The Madras conditions could only result in disappointment.

Lieutenant Nicholson's mission was one of those in which our Indian officials have equally shown strength and weakness. With no practical knowledge, and with second-hand information as to European processes, but applying intelligence to the improvement of rude native processes, they have often succeeded in establishing large and successful works. Such was the success of the late Joseph Hume, in setting up gunpowder works. So, too, the late Mr. Heath succeeded in making the finest steel, and though he did not achieve a commercial success in India, yet this able civil servant was enabled to discover valuable processes, and in his day to revolutionise the steel trade at home. Some of the first irrigation works, too, are noble monuments.

The zeal and exertion of Lieutenant Nicholson deserved a like success, but, as has been shown, circumstances were against him. He carried on a course of explorations in 1831 and 1832, and we are now able to recognise that he showed great ability, and that he achieved a certain success. His dispatches will be found in the report of Mr. Brough Smyth, already referred to. Mr. Smyth, with an appreciative feeling, has produced Nicholson's map, which shows that Devala and many other gold sites were recognised. The party of Lieut. Nicholson suffered much from fever, while his prospects of success were lessened by the want of a sufficient number of assistants, by bad tools, and by an irregular supply of necessaries for his men. In fact, he was in the situation of some of the early parties in Australia and New Zealand, which, from like causes, failed in what afterwards proved to be fertile ground for others. He had, however, peculiar difficulties, for the petty rajahs caused obstruction, they misled his people, filled up shafts, and felled trees to stop the paths. As treasure was not found at once, nor seemed likely soon to be found, there was great discouragement, and on the 25th of May, 1833, the Right Hon. the Governor in Council dispensed with the services of Lieut. Nicholson, and appears to have abandoned all hope. They did not attempt to remedy the manifest defects of the expedition, they did not follow up its indications, but determined that success was impossible, and the belief was arrived at that gold did not exist for any effectual purpose. The Kurumbars, however, went on with their small scratchings, as they may be called, and did this further good, that they kept alive the memory of the gold formations.

In truth, the labours of Mr. Sheffield and Lieutenant Nicholson were worthy of a better fate. The attention of Mr. Sheffield was naturally chiefly directed to the river washings, of which he knew many sites. He also referred to Wynaad. He, however, repeated that "There appeared no reason to doubt that golden ore is homogeneous to the soil in the mountains and hills of Malabar." He proceeds to name Devala.

Lieutenant Nicholson came across many curious facts. In one place he found no less than 27 old shafts. In another he observed 500 or 600 Moplahs working regularly, and paying royalties to the local zemindar or rajah, to the extent of some £700 a year. He sent up some stuff from the Devala mines, which gave metal in the proportion of about 90 per cent. of gold, and 8 per cent. of silver, and a portion of copper.

Silver, so often associated with gold ores, appears to be a large constituent of those ores, and it will give occasion for the operations of parting, which can be affected in the presidential mints.

One strange business of Lieutenant Nicholson appeared to have been the purchase of gold, with a view to an operation on account of the Govern- in which Mr. Sheffield had also been engaged.

It is to the credit of this officer that he saw his own deficiences, and proposed to go to England to purchase machinery. He also offered a plan for forming a mining department and school in India, by means of the Company's establishment at Chatham. These recommendations from a young man had little weight with the Government, which may be regarded as even less informed than himself. In the case of the gold regions, as in other cases in India, it will be found that English intelligence and enterprise are the real and efficient engines for the improvement of our empire, and must be applied in a fuller measure than the staff of the Government can supply.

It will be observed that the fever incident to the district was regarded, half a century ago, as it is now, as a serious impediment, and this was a discouragement for gold working. It so happened that the availability of the district for coffee-planting engaged attention, and when once this was seriously undertaken, Wynaad and the neighbouring countries were occupied, and turned to account, notwithstanding all obstacles. The planters gradually became aware of the gold finding, and turned their attention to it.

In October, 1857,* the acting collector of Malabar drew attention to the arrear of taxes payable by the rajahs for the right to mine, and some information as to the gold workings is derived from his reports. He could not define the exact localities in which the gold was quarried and washed, as it was obtained in very many places, interspersed though a tract of country extending for 30 or 40 miles along the western face of the Ghauts, and in parts along their summits. He stated that circumstances had altered so much, that the business had greatly gone down within ten years, so that many of those who understood the art had betaken themselves to other pursuits, and had carried away with them the knowledge of the localities richest in ore. As it was, much of the work, as it had been in Lieut. Nicholson's time, was carried on by slaves; a significant testimony of the poor returns. By 1858, whole families had been diverted to the employment of the coffee planters. It was about this period that, for a time, I acted as honorary agent to the Association of Planters of Western India, and the gold resources of the region particularly attracted my attention.

It was not until 1868 that the matter of gold working was seriously treated, and then by Australians who had settled in Wynaad. In July of that year, Mr. H. S. Sterne, who had six years'

* See authorities recorded.

experience as a gold digger, applied to the Government for leave to prospect for gold and other metals on Government land in the Madras Presidency. Permission being granted, he prospected in various places, but with what success is not known.* Somewhere about the same time, Mr. G. E. Withers began to prospect, and became convinced by inspection that the reefs were auriferous, and deserving of attention. Owing to his labour and the enterprise of Mr. T. W. Minchin, of Hamslade, near Devala, machinery was erected for reducing the quartz found in the veins of the Skull Reef, and reefs within the area of the company, which was called the Wynaad Prospecting Company.

From this period, applications have been continued until now for permission from the Government to work gold on private estates or on public land. These operations attracted much attention, and culminated in what appeared to be, in 1876, a settled industry of gold working, but the trials proved unsatisfactory, and, from one canse or another, great discouragement prevailed.

The chief of the original Wynaad companies were, after the Prospecting Company, the Alpha Mining Company and its dependency, the Prince of Wales Quartz Reef Gold Prospecting Company. These companies were chiefly under local auspices. By this time the Government of India had obtained the services of Mr. R. Brough Smyth, then in the employment of the Government of Victoria. As to their operations, much information is contained in the Appendix A, dated 18th February, 1879, to the report of Mr. Brough Smyth, p. 63. This is a report from Mr. Smyth to the Acting Secretary to Government in the Revenue Department, in consequence of instructions, under date 10th January, to ascertain how it was that, with good gold ground, the Alpha Company had not succeeded. The mining operations of this company began in February, 1875, and ceased in March, 1876, during which about 780 tons were raised from the main Skull Reef. From this only 91 ounces of gold were obtained, or at the rate of 2 dwts. 8 grains per ton. Of this, however, 6½ tons treated at the Wynaad Prospecting Company's works yielded 19 dwts. 22 grs. per ton, or nearly an ounce. The operations were, therefore, on a very small scale, and afford very small materials for arriving at a judgment.

On the 1st June, 1877, the Prince of Wales's Company took possession of the Alpha Works under agreement, but did not begin work until the 17th August, 1877, continuing to mine until the end of February 7th, 1878. The value of the gold got was rather more than 8,000 rupees from about 320 tons, and even that is not a mercantile result. The average yield was nearly 10 dwts. 12 grains.

It appears the machinery was inadequate, but a main cause of failure was the roasting of the quartz in kilns, before sending it to the mill. The result reported was that the fusible lower sulphides coated the gold, and prevented its amalgamation.

On comparing the average yields with those furnished by Victorian statistics, Mr. Smyth found such yields in Victoria favoured large results and large dividends. He came to the conclusion that under adequate arrangements the Alpha property ought to give very good returns.

* Report of R. Brough Smyth p. 10

Among the vicissitudes of this history, is to be recorded that parties involved in the disaster of the great Glasgow Bank, were concerned in these mining operations. It fortunately happened that some far-seeing men, among whom may be mentioned Mr. R. Palmer Harding and Mr. Samuel Jennings, determined to turn the gold properties to account. Thus a new element of enterprise favoured the contest.

At the same time, the sagacity of the leading director in the Moyar Coffee Company, Mr. W. J. Rhodes, gave further strength to the new movement. Mr. Rhodes, with his colleagues, acquired the mining rights for the Coffee Company, and thereby obtained for it advantages of an exceptional character, though these services have not yet been adequately compensated.

The conviction impressed on a number of able men of the real character of the district, resulted, naturally, in the determination to prove its resources. The missions of Mr. R. Brough Smyth to South India, for which he was retained by the Moyar Company, undoubtedly greatly co-operated to strengthen these efforts, and to consolidate public opinion. Bringing to bear an acquaintance with Australian operations, his enthusiasm did not exceed his caution, and if any have been excited by his descriptions, they must have neglected the reservations he expressly made. Going into a country which, to the regard of others as well as of himself, presented the aspect of a great gold region, he had to give some general appreciation, by which its character could be understood. For this purpose he laid down broad lines, but with the express reservation that these were not determinate, and were subject to correction.

In despite of himself, many believe that the reefs, roughly sketched, are as exact as the determinations of the Indian geological survey, and that deductions may absolutely be drawn from such data. Other observers have applied themselves to the task of working out, in detail, some particular reef, and have given to it a more precise bearing, differing from that proposed by Mr. Smyth. At page 18 of his report, this gentleman says:—

"It has been considered advisable to use great caution in suggesting the probable connexion of the outcrops of quartz, as they appear on the surface—in laying down hypothetical data—so as to connect one outcrop with another. The direction of the lines of reefs may, from the surface indications, be guessed at; it can be ascertained in no other manner than by extensive explorations; and the facts mentioned in other parts of this report justify hesitation in laying down, as absolutely beyond question, any line of reef in the Wynaad."

He enforces this from the experience of Australia.

Nothing can be clearer than Mr. Smyth's warning (p. 19)—

"It is not unlikely, however, that the first attempts will fail. Speculative undertakings having for their object the making of money by buying and selling shares, are commenced invariably by appointing secretaries and managers at high salaries, and the printing of a prospectus. This is followed by the erection of costly and not seldom wholly unsuitable machinery; no attempts are made to open the mine; and then, after futile endeavours to obtain gold, and a waste of capital, it is pronounced and believed that gold mining on a large scale will never prove remunerative. It is pro-

bable that this will be repeated over and over here, as in other gold mining countries, until some one of the mines is opened by experienced persons, who desire to secure profits, not by dealing in shares, but by mining."

In the last year, 1880, and in this, numerous companies have been formed on a large scale, and great speculation in the shares has taken place on the Stock Exchange. While we may look for fair results from fair mining, and, it is to be hoped, for large dividends, after a difficult time, we must also look out for a large amount of individual loss, to be measured only by the greediness of the speculating persons. Some of these losses will be most severe, as, step by step, the gamblers are drawn in, stimulated by the real or supposed gains of others. Those buying at the top of an exaggerated premium will sustain all the distances of fall from that height to the lowest collapse, when the concern is sold off as worthless. Then the premium will be lost and also the subscribed capital. It will, however, be seen that the community will not suffer in the same degree as the individual, for the man who sold at the premium will have his premium. So, too, the subscribed capital will not be lost to the community, as what is paid to several of the companies for the purchase of the properties is a mere exchange. Much of the operation is, indeed, a gambling with counters, and none the less to be reprobated.

V. Some very good descriptions of the Wynaad and the Mysore districts have been published in the memoirs accompanying the Geological Survey of India, particularly the report and map of Mr. King, in May, 1875. Mr. Brough Smyth, in his reports, has entered into valuable local details. Mr. Oliver Pegler has given a general mineralogical sketch of much interest, which he has confirmed by subsequent explorations.

A map of the gold regions, by Mr. James Wyld, the Geographer to the Queen, is the best record we have as yet of the general conditions and the various discoveries.

Mr. Oliver Pegler says* that the range of mountains of the Wynaad is of ancient formation, belonging to the paleozoic period, more especially to that of the Silurian formation, a matter of much interest. The highest peaks, as in the neighbourhood of Ootacamund, are formed of hard, dense, and crystalline rocks of the metamorphic series of granites, syenites, &c. The more fissile varieties are also here present, and, being softer, have yielded to the disintegration and denudations of time, and have formed the valleys and dells adjacent to the peaks.

These softer rocks are of a much higher colour than the harder granite and crystalline formations, and give a red and brown appearance to many portions of the surface of the country. The average height ranges from 7,400 to 8,400 ft., and the whole of the formations are impregnated with black magnetic oxide of iron, which, after a shower of rain, appears as black sand on surfaces where the water has run over in streams. This is particularly noticeable along the road sides. The crystalline rocks continue for a considerable distance down the slopes towards the Wynaad country, becoming lighter in colour, coarser in texture, but more laminated and fissile in structure, changing into the gneissic and more laminated varieties of metamorphic rocks.

* *Mining Journal*, January 17th, 1880, p. 67. In the *Mining Journal* will be found preserved, as customary, the current information on the subject.

The extent of the available working ground in the Wynaad is, says Mr. Pegler, very great, and Mr. Brough Smyth, within a small area of 23 miles by 12, or some 250 square miles, determined no less than 90 outcrops of ore reefs. Some of these surface specimens were very rich, at the rate of £750 worth of gold to the ton.* The Monarch Reef, near Devala, has been traced far above nine miles. The Mysore district is equally well spoken of. There is no doubt, indeed, of a truly auriferous region, and one of good character, extending over a wide area.

The whole surface of the ground, writes Mr. Pegler, is contorted, upheaved, and thrown about, forming upright ridges, valleys, peaks, rounded hills, and depressed surfaces. It is most difficult to determine the true strike of the strata generally. The whole country is ramified with a run of gold quartz veins, which are true reefs. The general run of these reefs is parallel, the direction of strike, according to Mr. Pegler, being almost generally, in the Wynaad, north and south, a few degrees west of north, and east of south. The dip of the reefs is very low, as seen at surface, and most generally to the east, varying, when cropping out on the brow of the hills, especially when heavily developed, from almost horizontality to from 20° to 39°, and increasing in dip in lower grounds. These reefs, which are met with in every part of the country, are often of great breadth, up to 15 ft., 20 ft., and 30 ft. of thickness, are composed of white crystalline, compact quartz, identical in every respect with the reef quartz of Russia, Australia, California, Nevada, or any other known gold-bearing country.

Such being the resources to be worked, there come questions as to the local means for working. Water, the great necessity for gold crushing, where fuel is not readily available, is supplied by a heavy rainfall. Mr. Brough Smyth states that the rainfall at Devala, during the years 1869 to 1875, varied from 109 inches to 117 inches, and at Vellerymulla, during four years, from 100 inches to 139. As much as one inch of rain sometimes falls in an hour, and nine inches in a day, the destructive effects of which in some places may be conceived.

Where water is scarce and fuel dear, a relatively rich spot may be less valuable than an estate with a poorer gold reef.

The next natural commodity is timber for mine timbering, and tools, and for fuel, and this, within certain limits, can be freely obtained. It will tax the forest administration† to keep up this supply, and to prevent waste.‡

Labour, apart from technical labour of imported miners, is available on the spot. The Moplahs and Kurumbars have also been accustomed to gold working. The coffee plantations have trained up labourers. It will, however, prove fallacious to form estimates on the present rate of wages.

So far as Europeans are concerned, climate is to

* *Mining Journal*, already quoted.
† See Sir Richard Temple's Paper, Society of Arts' *Journal*.
‡ A list of woods supplied by, will be found in Mr. Brough Smyth's Report, pp. 58, 59.

be considered. With a heavy rainfall, and luxuriant vegetation, malarious localities are prepared, and there are seasons and places to which Englishmen should not be exposed. Miners, however, chiefly work under ground, and in mines at home in a very high temperature. There are, however, places where the coffee planters are able to reside on their estates with their families during the whole year. Then there is the station of Ootacamund, a retreat for health and pleasure within the neighbourhood, which will afford a great resource. A mining district, with a floating population, is not, however, to be regarded as a colony, like New Zealand, in which men are to spend their lifetime till old age.

Accessibility may be regarded in connection with the other conditions. Within four miles of some of the Mysore mines, is a railway station in union with the main Indian system. Although the Alpine railway to Ootacamund has not yet been constructed, the plan is delayed for want of support, and gold operations will stimulate its commencement. From such particulars as to these plans as have been kindly afforded to me by Mr. Juland Danvers, the head of the railway department, and Col. J. F. Smith, the chairman of the Madras Railway, there appears to be no reason for hesitation as to some provision for passenger transit being ultimately made. So far as Wynaad is concerned, there is the great advantage of access to Calicut and other ports on the western coast, within 30 or 40 miles of some of the gold-bearing formations, the elevation to be reached is, as already described, great, and to be ascended over a country much cut up. Thus, with a seaboard nearer than in New South Wales, Victoria, Queensland, or California, and more accessible than San Francisco, nothing heavier than a few hundredweights can now be got up to a mine without difficulty and uncertainty. All the weight has to go up, supplies for men and mines—except such food as can be locally got—but the weight to go down is in pounds of gold, easily to be carried—a return freight quite out of proportion.

On the seaboard, machinery can readily be placed, but it must be so devised as to be suitable for mountain regions. Upon the general nature of gold machinery in Australia, the recent paper of Mr. Alfred S. Lock, read before the Society of Arts 19th January (*Journal*, p. 131), and the adjourned discussion in *Journal* of the Society, p. 160, may be usefully referred to. As chairman, I made some remarks from my own experience and observation, not without connection with the present paper.*

With regard to gold lands and regulations, the Government have dealt with the matter judiciously. They have not been led astray by false notions of administration, and of large gains to be directly enforced, but have turned their attention to the practical experience of Australia.†

The late Governor of Madras, the Duke of Buckingham, showed a liberal appreciation of their importance, by visiting the gold regions on the 1st November, 1878, when gold was found in his presence.

VI. If gold should be produced extensively, it will settle the question of currency and exchanges, for not only will gold be at hand for coinage, but silver, thereby diminishing the import of silver. The Wynaad gold has a large proportion of silver, say 15 per cent. in weight.

Mr. Daniell‡ and the *Economist* have pointed out how large a proportion of the import of specie into India consists of gold. Although during the latter years the import of silver rose so high as to be from £16,000,000 to £20,000,000 per annum, yet the gold import also ranged high, reaching in one year nearly £10,000,000. In the latter period we have the extraordinary silver import of nearly £16,000,000 in 1877-8, yet the gold import was kept up steadily. Upon this Mr. Daniell rightly dwelt, and it is of such material import to the consideration of a gold currency for India, that it will be very useful to reproduce the tables in the *Economist* of 27th November, 1880.

* Mr. Lock also proposed a Gold Institute, which is well deserving of realisation.

† See report in R. Brough Smyth's report.

‡ Book of Mr. Claremont Daniell hereafter quoted, and his letter in *Bullionist*, 23rd October, 1880, p. 1163.

VALUE of GOLD and SILVER respectively imported into British India, by sea, on Private Account and on account of Government, from the United Kingdom, China, and other places during the official years 1869-78.

GOLD.

	1869.	Per cent.	1870.	Per cent.	1871.	Per cent.	1872.	Per cent.	1873.	Per cent.
	£		£		£		£		£	
The United Kingdom	1,595,893	31	1,609,484	28	498,207	18	1,340,696	38	751,417	29
China	1,501,210	29	1,542,785	27	1,505,352	54	1,331,746	37	860,968	33
Other places	2,079,873	40	2,538,131	45	779,015	28	901,336	25	1,009,986	38
	5,176,976		5,690,400		2,782,574		3,573,778		2,622,371	
	1874.		1875.		1876.		1877.		1878.	
	£		£		£		£		£	
The United Kingdom	273,472	17	454,621	22	267,228	15	480,666	33	203,093	13
China	812,651	49	1,083,584	52	1,032,982	56	406,029	28	845,212	53
Other places	562,685	34	551,031	26	536,171	29	557,017	39	530,622	34
	1,648,808		2,089,236		1,836,381		1,443,712		1,578,927	

Silver.

	1869.	Per cent.	1870.	Per cent.	1871.	Per cent.	1872.	Per cent.	1873.	Per cent.
	£		£		£		£		£	
The United Kingdom	3,165,863	32	2,041,224	25	200,796	7	5,560,815	69	1,107,329	57
China	2,953,835	29	3,707,567	45	1,247,854	47	1,324,141	17	161,273	8
Other places	3,859,280	39	2,515,616	30	1,213,599	46	1,115,079	14	665,612	35
	9,978,978		8,264,407		2,662,249		8,000,035		1,934,214	
Price of Silver in London ..	$60\frac{7}{16}$d.		$60\frac{9}{16}$d.		$60\frac{1}{2}$d.		$60\frac{5}{16}$d.		$59\frac{1}{4}$d.	
	1874.		1875.		1876.		1877.		1878.	
	£		£		£		£		£	
The United Kingdom	2,147,305	52	4,376,881	72	1,979,566	57	7,305,278	73	12,716,330	81
China	912,967	22	353,303	6	349,507	10	610,472	6	1,761,728	11
Other places	1,083,454	26	1,321,627	22	1,135,268	33	2,076,658	21	1,298,474	8
	4,143,726		6,051,811		3,464,341		9,992,408		15,776,532	
Price of Silver in London....	$58\frac{5}{16}$d.		$56\frac{7}{8}$d.		$52\frac{3}{4}$d.		$54\frac{13}{16}$d.		$52\frac{9}{16}$d.	

Value of Gold and Silver respectively Imported into British India from Foreign Parts in each of the undermentioned Official Years:—

Official Years.	Gold.	Per Cent.	Silver.	Per Cent.	Total.
	£		£		£
1855-56	2,508,353	22	8,792,793	78	11,301,146
1856-57	2,176,002	15	12,237,695	85	14,413,697
1857-58	2,830,084	18	12,985,332	82	15,815,416
1858-59	4,437,339	34	8,379,692	66	12,817,031
1859-60	4,288,037	26	12,068,926	74	16,356,963
1860-61	4,242,441	40	6,434,636	60	10,677,077
1861-62	5,190,432	35	9,761,545	65	14,951,977
1862-63	6,881,569	33	13,627,398	67	20,508,967
1863-64	8,925,412	39	14,037,169	61	22,962,581
1864-65	9,875,032	46	11,488,320	54	21,363,352
1865-66	6,372,894	24	20,184,407	76	26,557,301
1866-67 11 months	4,581,472	35	8,655,433	65	13,236,905
1867-68	4,775,924	41	6,999,450	59	11,775,374
1868-69	5,176,976	34	9,978,978	66	15,155,954
1869-70	5,690,400	41	8,264,407	59	13,954,807
1870-71	2,782,574	51	2,662,249	49	5,444,823
1871-72	3,573,778	31	8,000,035	69	11,573,813
1872-73	2,622,371	58	1,934,214	42	4,556,585
1873-74	1,648,807	29	4,143,726	71	5,792,533
1874-75	2,089,236	26	6,051,810	74	8,141,046
1875-76	1,836,381	34	3,464,341	66	5,300,722
1876-77	1,443,711	12	99,92,402	88	11,436,119
1877-78	1,578,927	9	15,776,522	91	17,355,459
1878-79	1,463,049	20	5,593,699	80	7,056,748
1879-80	2,050,392	18	9,605,001	82	11,655,393
	99,041,593	30	231,120,196	70	330,161,789

As these two questions of currency and exchange are closely connected, so, in the joint considerations, they have been mixed up, and the difficulty of arriving at a consideration has thereby been aggravated. I am not unaware that the opinion of many of my friends among the economists is opposed to a gold currency in India, but, with every respect for theoretical considerations, it will be gratifying to see the solution of facts. The currency settled, the exchanges will settle themselves in a manner satisfactory to economists.

As there are two schools of thought in political economy, and although the historical school of the old English economists is rather out of favour, there will be no harm in regarding India historically. History shows us that it had an abundance of gold and a gold currency, so that, although prices were small, the small gold fanam was a favourite coin, just as we find similar minute coins in the regions to the westward. It is, however, believed by many to be impossible to work a gold currency in India. A gold currency, nevertheless, will work with a low rate of prices, and we are not obliged to regard a gold currency as a matter solely of sovereigns and mohurs.

In those ages, when India raised gold and traded with the Arab regions to the eastward, there could have been no great difficulties, for in those regions the range of prices was also low. The Mussulman conquests disturbed the sources of gold supply in India, and reduced the stock, and at length we come to the state of affairs which we have in this day, wherein India has not merely to contend with the metallic question, but it is brought in contact with the enhanced prices of the west, and with a machinery of production which destroys local manufactures. A like conflict is going on in Japan. In both countries a partial remedy is being obtained by the rise in wages and commodities. The contest is, however, with a growing antagonist, because the process of mechanical invention in the west creates an ever craving demand for these new and most expensive appliances of civilisation. Railways, iron and steel ships, and arms of precision, typical necessaries of the new social system, are only to be acquired at a real sacrifice by the undeveloped nationalities.

While Australia can make its payments with

wool, and Peru with guano, India has to provide in many parts for a most dense population from the produce of the soil. Commodities for exchange and export are only to be obtained by displacing articles of food. Undoubtedly, the local circumstances of India are peculiar, and create difficulties in the way of adjustment, but these can be met by due provisions. In this, as in other cases, India must be administered and legislated for, not directly on western considerations, but in reference to its own circumstances, still always with the direct end of bringing India to the standard of the empire and of Europe.

It is the fact that, historically, India had a gold coinage, and there can be no local objections to its having a gold coinage now, as well as a silver coinage; indeed, any objections to this must come from the outside. In the world we find a gold coinage predominant, and those who object to a gold coinage for India are those who object to bimetallism as a system, and maintain a gold currency here, and are, consequently, to some degree, inconsistent. Undoubtedly, any change in India must be attended with disturbance, and this is raised as an objection to change. The disturbance, however, is already most continuous and severe in relation to the rupee currency, and the objections to future disturbance become small in degree, when we have to regard the prospects of improvement to be realised. As to change in India, there is no alarm to be entertained as to change by itself, provided that change be judicious. India, like the whole earth, is under the dominion of change. That great engine of society, the railway, which affects the transit of men and the transport of commodities, has done, and is doing its work of change in India and elsewhere, and the people accommodate themselves to it, and will never abandon it, but for some other improvement.

There are those, and these are many, who long since have advocated a gold coinage and a gold standard for India, in communion with the rest of the empire, and I have been among them. So strongly has this necessity been felt, that measures for its realisation were at one time far advanced. Had they been years ago put into operation, by this time the consequences of disturbance would have passed away, and India have been brought to its true position in connection with the rest of the world.

This has not come; the question has been taken out of the domain of practical politics and left in that of theoretical economy. With all due respect for economists, administration is not to be under the yoke of theoretical, miscalled political economy. The distinction has, unfortunately, not been sufficiently regarded, though in India there have been many statesmen whose political instincts have induced them, on more than one occasion, to adopt the rules of real reason in preference to those of scholastic doctrines. Political economy has suffered the reaction consequent on its abuse, and is threatened with absorption by the so-called social science, which is only a meagre substitute for political science. By attempting to apply political economy beyond its bounds, it has been exposed in more than one country to the supremacy of the socialist school. Nothing is of more moment to India than the rightful administration of political knowledge as an applied science. If its peculiarities are to be regarded, then its relation to the rest of the world is also to be regarded, for India is at this day bound to our empire by political ties, and to the world at large by commerce, and cannot be left in isolation. Many of its supposed peculiarities are common to other countries. Were India independent, as Chile or Peru, it would be drained, as it is now. Chile, for instance, has to pay as much to us in proportion for warlike supplies, for interest on railways and loans, for our share in mines and in commerce, and for the maintenance of the English colony there, as India does.

Most of the alleged grievances have no real connection with the necessity of English rule in India. This relation will have no more real effect when the condition of India is altered by the gold supplies. The gold supplies will be coined, and much of this coinage be exported, as is that of Australia. There is no reason, then, why this coinage should not be like that of Australia in sovereigns, although smaller coins may be struck for local use. Coins are not always used for circulation, some are hoarded, some used as ornaments, some re-melted by the goldsmith. In England even, many a sovereign goes into the chain maker's melting pot.

The balance of facts is in favour of a sovereign coinage for India, and then the silver rupee coinage would become token money. If India exports gold sovereigns, the exchanges will be under modified conditions, both as regards the imperial operations and those with abroad.

In my range of experience, there is one quality of the sovereign standard which particularly recommends it for India. The pound sterling is something more than an English denomination. As it is exempt from the tampering which has affected the currencies of so many countries, it is accepted in all the money markets of Europe as the chief denominator for what are called international currency or bonds. The London money market is also regarded as safe from the revolutionary attempts which have from time to time created alarm in continental countries. Bonds with coupons, solely or alternatively payable in the pound sterling, are preferentially dealt in in all the great money markets. They have an ultimate determinable value, giving them the character of a resource and a reserve under all circumstances, and they have a special property for purposes of remittance, either as bonds or coupons, for the settlement of transactions, constituting an effective international currency.

One great want of India is capital, for whether technical financiers for a time impede its application by an artificial entanglement with the public revenue, events will enforce the emancipation of capital from these trammels. At present, the supply of India, as compared with our colonies, or foreign countries, for public works, provincial or city loans, is most contemptible. When the demand comes in force, it will be on a large scale, and it will, therefore, be a great benefit to have the participation of foreign markets, as in the case of the late participation of the Paris market, which gave opportune relief.*

* It is impossible to quote all that has been written and said on Indian coinage. Before the Society, in this Indian Section, valuable papers have been read by Col. J. T. Smith, and have been stoutly contested. What can be read with much benefit is,

The chief points that are brought forward in this paper, are—That by traditions and history gold is known to be produced in Southern India; that the extent of the formations has been proved by successive explorations; that for the working of these formations there are to be obtained labour, water, timber. The effect of the production of gold has been explained with regard to currency and exchanges, and prices.

VII. In closing this paper, I must renew my acknowledgments to many who have assisted me, and whose names I have quoted, Mr. R. Brough Smyth, Mr. Samuel Jennings, Mr. W. J. Rhodes, Mr. Juland Danvers, Col. J. T. Smith, Mr. Andrew Cassels, Sir W. Rose Robinson, Mr. Claremont Daniell, Mr. James Wyld, Mr. R. Palmer Harding, Professor Rudler, Mr. O. Pegler.

DISCUSSION.

Mr. W. D. Powles said he had little or no experience in Indian gold mines, but he had experience in other parts of the world, and a word or two with respect to the profitable use of tailings from gold mines, which had previously proved unprofitable, might be of some interest as illustrating gold mining in general. His family bought the tailings of a mine in Colombia, which had been worked for the free gold alone, having made a contract to take them for 12 years for 50,000 dollars, whereas, until then, they had to be thrown away as useless. They erected a small furnace in a very rough way, and from those tailings produced a profit of three or four thousand dollars a month. Not long afterwards, his father sold his share for 165,000 dollars. Of Indian gold mines, he only knew what he had read of Mr. Brough Smyth's reports, and what he had seen at the School of Mines; and he knew, from the geological formation, that quantities of gold must exist in the quartz reefs; that there was no doubt about. The only question was whether it could be obtained at such a cost as would show a profit on the working. He regretted that the enterprise should not have a fair start, the amount of capital on which dividend would have to be paid being rather heavy. Even supposing it to be a *bonâ-fide* operation, the profit on the actual working expenses would have to be rather large in order to show a profit on the whole capital—he meant at the commencement, because he had no doubt that later on, when the proper appliances were imported, in order to produce the gold at its minimum cost, they would be able to pay a dividend on a much larger capital, but he regretted that it should be rather heavily handicapped at the beginning. His experience had been chiefly in the United States, in Colombia, and in South America, in both gold and silver mines, and, on another occasion, he should be glad to discuss both the mining and smelting of gold and silver ores.

Mr. Lock wished to say, in connection with Mr. Hyde Clarke's observation that the capital invested in machinery was the real capital, that that showed how important it was that the machinery should be of the very best description you could possibly have for the purpose, and in order to that, there must be suitable knowledge of what was required. A short time ago he had made the suggestion, from the ignorance which seemed to prevail on this subject, that this country wanted a Gold Institute, where the different appliances requisite for the proper treatment of gold ore could be examined, their merits tested, and the whole subject thoroughly ventilated. Gold mining was a science, and must be studied like any other science. As Mr. Hyde Clarke mentioned, suitable and unsuitable appliances had already been used in India. Mr. Brough Smyth's report referred to a company started some time ago, the Alpha, which sent out some machinery with which the quartz cropping out on the top of the reef was crushed; it therefore must have contained all free gold, and should have been the very easiest material to deal with possible. But so far from getting gold, they lost all their mercury, and the company came to grief, not because there was no gold in the ore, but because the appliances used to get it out were of no value. Within the last three or four months, he had seen some machinery which was being sent out for some company or private firm in India, which he was perfectly certain could never get out more than 50 per cent. of the gold in the ore. Gold mining in India was not only of importance to that country, but to all the world, because every ounce of gold, wherever obtained, became a circulating medium, which induced an extra trade, and passed all over the world. Within the last 25 years, they had seen a fabulous increase in exports and imports, which had almost entirely arisen from the vast gold discoveries in Australia and California. If there had been no gold discovered, that trade could not have been carried out. It became, therefore, a matter of great importance to every country, not only that gold should be got out of the ore, but also that as much as possible should be got out. Gold mining was one of the first enterprises which opened up any new country. Without gold mining, California would not have done much, and, certainly, without it, Australia did not make much progress; but the moment gold was discovered and worked, other industries followed, and the country became developed. He did not see why what had taken place in Australia and California, should not in like manner take place in India. Works would be created which did not now exist, which would call for further capital, and the country would take a totally fresh start. He was therefore most desirous to see that every company which entered into gold mining in India, should be, as far as possible, a success. They had to thank Mr. Powles for a most important statement, which showed that the knowledge of one man might make success, where the want of knowledge of the previous man made a failure. They wanted men like Mr. Powles. It seemed to him that knowledge could not be obtained unless there were some means taken, such as he suggested—the formation of a Gold Institute, where could be gathered together information from all over the world, and which could, in its turn, be redistributed all over the world.

Mr. Thomson asked what, in the opinion of those conversant with the district, was now considered to be the area of the gold field? This was an important element with reference to the great question raised by the paper, as to the probable great monetary and political effects of the re-discovery of gold. If, as he was informed, it was now certainly 500 miles square, he wished to know to what extent this gold field could now be said to extend. If the great district of Mysore were included, as well as the district of Wynaad, would it not be right to say that there was a very large territory now fit for European habitation. The success which his own company had had in importing Cornish miners, had given him the idea that we might have eventually a very large proportion of Cornish men or Australians permanently settled in the hill districts of India. If he were right, there would be a means of very seriously affecting the future of India in the charge for the army, because, if you had a large European colony in the hill districts, that colony would very easily be attracted still further by military service, and you would get a permanent resident population, which would very much reduce the

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"Gold in the East" (London: Strahan & Co.), by Mr. Claremont J. Daniell, B.C.S., of Moradabad, who has treated the question in a masterly and practical manner. In the appendix is an extract from General Ballard, Mint-master at Bombay in 1868. Mr. Samuel Jennings has dealt ably with the relations of gold and currency. (*Herapath's Journal*, 4th Dec., 1880.)

fifteen millions now spent annually on the Indian Army. Mr. Lock would very much add to the value of his observations, if he could suggest the best form of machinery. There was no doubt that some of the old-fashioned machinery had been sent out, but to what extent it was so, they would all be glad to learn. The suggestion of a Gold Institute would, he believed, be hailed by all interested in the subject, and the question he should like to ask was, whether something could not be done with the crushed quartz; he believed it contained a large quantity of silica, and it struck him it might be used in some way to advantage in cultivation.

Mr. Maxwell Lyte said the principal cost of treating ores for gold was the labour. Although he had not been in India, he had read a good deal on the subject, and he should be glad if Mr. Hyde Clarke could reassure them a little on the question of labour. The introduction of Cornish miners had been referred to, but he doubted if English labour could be got to work in such a climate.

Mr. Trelawney Saunders said he was not in a position to speak on gold mining, but he might make a remark on the question raised by the previous speaker, namely, the suitability of Wynaad for colonisation by Cornish labourers. He could only say he thought it would be very difficult to persuade them to work in a climate which involved a rainfall of something like 200 inches.

A Member said the rainfall all took place in three months.

Mr. Saunders said he did not intend to discuss that question, but there was no doubt that was something like the annual rainfall of the country, which had to be endured, whether it all came in three months or not. He viewed the progress of this speculation with great anxiety. They all knew that the subject of gold mining was not a new one, for it had been under the attention of that Government for the last 50 years. So long ago, the investigations made under Lieutenant Nicholson and others were not thought sufficiently encouraging to be proceeded with. At the same time, there could be no doubt that India had produced large quantities of gold; and the most encouraging fact he had heard, if it were a fact, was the result of the removal of a pillar from one of the old workings in one of these Wynaad mines, which was found to be very productive. As to the question of the earlier productiveness of India in gold, there was not much evidence; but there were probabilities, and there were also probabilities of the condition of labour under which gold mining was profitable to the former rulers. Supposing Tippoo Sahib produced large quantities of gold, there could be very little doubt as to the way he would have gone to work. He would have employed large numbers of men under various strenuous directions, regardless of life, or any of those considerations which had to be very carefully attended to by an English Government. Under such conditions, it may have been practicable to remove mountains, or conduct any operations with a greater amount of profit and a less amount of expenditure for labour than would be possible now. The question now was whether the introduction of machinery and the application of European skill would be a substitute for that plethora of labour which a Hindoo conqueror could apply. Perhaps that skill and machinery would be considerably counterbalanced by the large amount of capital with which the interests of the money market and speculators thought it necessary to load every undertaking into which they entered. This was becoming a very serious question, and was one to be regarded by all serious men of business as one of the first importance, and he thought some effort ought to be made in the City of London to put down this ruinous practice, which tended to overload and destroy the profit of any undertaking by the excess of capital imposed upon it. He said this, not with a view of counteracting the operations of these gold-mining companies, for he should be exceedingly thankful for their success, because he could see that if so, they would encourage other operations in other directions, which must greatly tend to the advantage of the people of India, as well as of Europe. He saw already symptoms of the increasing investment of capital in legitimate trade in India; and there was one thing to which we could point with pride in connection with our occupation of that country, that while we took upon ourselves the responsibility of ruling it, we excluded nobody from any good to be got out of it. It was that which gave us a claim to the consideration of other mercantile countries of Europe.

Mr. Christian Mast, as a teacher, hoped that the important question of technical education, in connection with this subject, would not be lost sight of, for there was no doubt that the success of these operations would depend in a large measure on the amount of intellect and investigation brought to bear upon them.

Mr. Dipnall said he came, probably like some others, as a mere learner, and the title of the paper gave no idea of how the subject was going to be treated. Mr. Hyde Clarke had treated it mostly from the productive, and political and social points of view, whilst the map had explained pretty clearly the topography of this particular rediscovery of gold mining; and when he heard the observations of some gentlemen who had spoken, and noticed on that map that the mining operations would be conducted in 10 degrees of north latitude, it showed to his mind that they would be conducted in a climate totally unfit for any great body of Cornish miners or other Englishmen. It struck him, therefore, that they must look either to native labour, or labour imported from China, and that they would not be justified in settling down in such a district a large body of European labourers. He would also suggest that when the rainfall was stated to be occasionally something like 300 inches in the year, or 10 times the average rainfall of this country, even if it fell in three months, the three months of deluge and nine months of arid weather by no means presented a climate suitable for the residence of Englishmen. It was, therefore, of the utmost importance that every possible inquiry should be made before any large number of Englishmen should be introduced there. With regard to the development of gold in India, there could be no doubt whatever, looking at the great mountain ranges, that gold did exist there to a large extent, and that, as in the case of copper and other minerals in ancient Greece, the imperfect manner in which the ores had been treated in former ages had only allowed less than half the products to be got out, leaving a large balance for future generations. They had recently heard from Sir Bartle Frere, that a similar observation applied to the imperfect mode of extraction in South Africa, there being as much left behind as was taken out. Some excellent allusions had been made to the mechanical part of the operations, and the question of improved machinery, but he did not think enough had been said about the chemical part or process, and how, by greater attention to that point, modes of extracting gold might be discovered which would produce it at a much cheaper rate. It struck him, without pretending to any scientific knowledge, that with the wonderful development of electricity going on, modes might be found of fusing gold which had not already been used, and this particular opening in India might present a field of operations, whereby, without the employment of enormous labour, European skill and science might be so directed, as that by a minimum of effort the greatest amount might be produced.

Mr. Andrew Cassels said the last two speakers had forestalled a great deal of what he meant to say. He agreed with the last speaker as to the unsuitableness of

the climate for English labourers, and he also shared the opinion of Mr. Saunders, that this matter had been very much overdone in London lately. He had glanced at the paper before coming, and was much pleased with the impartiality with which Mr. Hyde Clarke had dealt with the subject. What one gentleman had said about the imperfections of much of the machinery sent out was quite true. He had had a great deal of information privately from gentlemen connected with the districts, he had seen many reports and specimens of the quartz sent him, and his strong impression was that there was great disappointment in store for those who had embarked in this enterprise. Although he ventured to say this—and it required some little courage to say it in the face of strong opinions held by many gentlemen for whose opinions he had great respect—no one would be better pleased than himself if these golden dreams were realised. He greatly approved of the sentiment in the latter part of the paper, where the writer spoke of the effect of the great discoveries of gold upon India and on the exchanges, matters which had come home to most of those connected with India lately with startling effect. To speculate on what would be the result of large discoveries of gold, was at present scarcely possible. The great fluctuations they had seen in the last 12 or 15 years, in the value of silver, taught one to be cautious. Fifteen or sixteen years ago, there was a great agitation in India, chiefly originated by his brother, Mr. Walter Cassels, in Bombay, and by Sir William Mansfield, with regard to the introduction of a gold currency. Their arguments were, at that time, chiefly founded upon the fact that silver was scarce, being then 63d. per ounce, instead of 51d., as at present. They wished to introduce a gold currency, and he himself held much the same opinion. In that room, he read a paper bearing upon the subject, but since then silver had fallen so much in value that it was impossible to say what would happen. Let them see what the gold discoveries, and the result of the conference to be held in Paris in next April, would do for silver. It was pretty clear something would be done, and he indulged the hope that they would see silver regain some of its old value, and not remain, as at present, a great loss to the Indian revenue, and to every man toiling in India under a broiling sun, and the wife and children at home, to whom he had to forward a considerable portion of his earnings. There would be no greater benefit to Englishmen connected with India than to see some improvement in that respect.

Mr. Woolley said he was well acquainted with the district, and had some knowledge of gold mining, having visited other gold countries. He begged, with all possible respect to Mr. Hyde Clarke, to say that in this case the companies which had been formed had commenced, not by sending out the machinery, but by providing themselves with raw material. No doubt they had done it to an extent which perhaps in private life would bring them to bankruptcy, but the greater part of the capital which had been raised had been sunk, not in machinery, but in providing the raw material upon which they must operate, and from which they hoped to extract satisfactory results. As far as his own opinion went, if skill were brought to bear, the results would far exceed anything ever seen in Australia and California, but it all depended upon that. There was, therefore, every requisite. One of the gentlemen had spoken about rainfall, but he was in India last year, and the rainfall, instead of being 300 inches, or even 200, did not average 100 inches; 200 was quite the maximum. And the Cornish miners, even if they were there, would only be exposed to the rain during their passage from their quarters to the works. He quite agreed that to send any quantity of English labourers to 10 degrees north latitude would be an absurdity, for the climate was unsuitable to a European working out of doors. But those who worked the mines would not be out of doors, and would not be exposed to the sun. There was, however, no great necessity to take Cornish miners there. There was every description of first-class labour to be had on the spot; and the gold industry, as far as it had gone, had not affected the price of labour at all. If it had, it would have affected his pocket, as a large coffee grower. The supply of labour was almost inexhaustible, and there were great muscular fellows there, who were capable of doing any amount of work, some of them miners almost by birth, who were ready to take 6d. or 7½d. a day, without the slightest hesitation. What one wanted of Cornish miners, was the skill to superintend this labour and, bring it to bear in such a way as to produce satisfactory results, and the quantity of such skilled labour need not be much. As regards the area, he believed that at present the gold bearing area of the colony of Victoria was 1,400 or 1,500 square miles, whilst the known auriferous area in Wynaad alone was twice that. The colony of Victoria had, two years ago, over 800 mining companies in operation, and in India we had now 20 or, at the utmost, 25 on twice the area. How could it be said then that the companies were too many, or that they were almost certain to come to grief. There was no prospect of such a thing, if only proper skill and intelligence were brought to bear.

The Chairman said he would not detain the meeting long, because the several gentlemen who had treated the subject had pretty nearly exhausted it, but would merely confine himself to two or three practical points. One was the area of possible gold-field. He could not himself speak on the area along the Eastern Ghauts; gold-fields seemed to exist in the Ghauts on both sides of the peninsula. The Mysore gold-fields were practically on the verge of the Eastern Ghauts. The Western Ghauts he knew much better, having been connected with that country since 1842, and knowing it all very well. He noticed what Mr. Brough Smyth said the other day, to the effect that not one-twentieth part of the real gold area had been prospected in any degree. There were some gold washing in streams and rivers going on all along the ghauts in Canara, and right down the whole way, almost to Cape Comorin, but he believed they might accept it, that for the present, at all events, that part of Wynaad now attracting attention will continue to be the nucleus of the work. The labour question, doubtless, was a very important one, and Mr. Woolley, whom he knew to be a practical employer of labour in Wynaad, had given some very useful and encouraging facts as to the present condition of the labour market, but what would be the effect of a large development of the gold industry beside the coffee industry, was very uncertain. In the meantime, there was no doubt that the gold industry started on the West Coast of India, as respects labour, in probably a much better position than in any other country in the world. You started with a teeming population, which certainly would afford all the labour which would be required for the present. Wages, however, would rise, and must be taken into account. Within the time he had been in India, the price of labour had certainly doubled, and a large increase in the demand must have a farther effect upon it. He was glad Mr. Cassels had drawn special attention to the caution required in dealing with this question, and he himself felt some anxiety, from the fact that the companies were going out very heavily handicapped by the large prices paid for land. As regards the climate and the employment of English labour, he thought that, beyond the supervision required, the importation of large numbers of English would not be requisite or desirable. He would not follow Mr. Hyde Clarke into the interesting subjects of coinage and exchanges in India. He entertained grave doubts whether a poor country like India or Japan could practically use a gold coinage for some time to come. One fourth part of the population of Southern

India was practically bartering grain they raised or earned for such commodities as they used, or used shells or copper as tokens; the country was a very poor one, and he doubted whether, being in such a condition, it could float a gold coinage. Any way, as Mr. Clarke had said, they would have to mint the gold in some form or other, and then it would be practically decided whether such a coinage would be a useful form of popular currency. He observed that the proper alignment of the connection between the Wynaad and the railway system of South India lies through the Mudelmada (Moyar valley) district, and thence *viâ* Bandipur with Mysore and Bangalori, whence was derived the supply of grain and labour, and not over the Nilgherry hills with the Coembatore district by the Kunur valley. The so-called Alpine railway up the latter valley would prove a snare and delusion.

Mr. Hyde Clarke said the necessity for a reply was very much less than it appeared, because several of the points raised had been already dealt with by him in his paper, as would be seen on its perusal. Beyond that, the necessity of his giving a detailed reply was removed by the nature of the discussion, and he had stated at the outset, that he was much more anxious to have the benefit of this discussion, than to put forward any views of his own. It had been a great advantage, not only that they had men taking part in it, well acquainted with India, and deeply interested in it, but men of very wide experience in various parts of the world. In fact, there was hardly a great gold region which was not represented there in the discussion, or by the presence of some one practically acquainted with it. Mr. Woolley, to a great degree, had answered some of the other speakers, but he thought Mr. Woolley had misunderstood him on one or two points, and that, when they came to compare notes, they would be found in substantial agreement. There was certainly no question of the employment of a large amount of European labour. The great advantage of the South Indian region was that it had a large supply of labour, but at the same time they did want skilled labour. Some gentlemen seemed to think it was impossible for a Cornishman to go to a country of that temperature, or one which had a large rainfall. But the rainfall was a very great advantage to gold working; and, with reference to the climate, he would remind them that Cornish miners went to very much worse countries than India. Some of Mr. Woolley's neighbours in the Wynaad, although that was an unhealthy position, had remained the whole of the year on their coffee plantations, so that it could not be altogether so bad a climate. They must, however, recollect that the miner was not going to work on the surface, but under ground, or in case of reduction operations, under shelter; and it was by no means necessary he should be exposed during all periods of the year. In such cases the white labourer, unacclimatised, went somewhere else, and it was a great advantage in this case that there were some very healthy districts in the Neilgherry hills where he could go. On a careful and candid consideration of the paper and the discussion, he thought the main part of the objections would be removed. Mr. Cassels had brought forward many important facts which must not be left out of consideration. He believed they would all see changes in the relative position of silver, and what Mr. Cassels had said appeared to him a reason why they should look at this subject encouragingly and not distrustfully. In the paper he had been careful not to encourage share speculation, but at the same time to ask them to look at the possibility of practical results being obtained. He would rather go by the experience of those practical men who were present, and who knew what the resources of the region were, than of the suggestion of a mere doubter. For his own part, he looked upon it that disastrous speculation would take place; but they had no duty, for the sake of gamblers who chose to put their stakes on the table, to stop legitimate operations. Why were they to protect men who had gone in for gambling? The present condition of the share market, with regard to Indian gold companies, in his firm belief, was nothing to what they would yet see. For two years he had foreseen that in all likelihood there would be a gold mania, and that speculation would take the form of gold mining. If so, they would see reproduced what they had seen before, these shares would run up to fabulous premiums; but what had that to do with gold mining? They could not prevent such a thing. These men were gambling with counters; men were putting their money into gold mining shares who would stake their money on the Derby, and were they to protect them in either case? Why should they stop the whole operations of the empire for the sake of persons of that kind. What they had to look to were the persons really interested—the population of India, whose welfare was at stake. One point referred to by Mr. Lock and himself was the effect produced on a district by the introduction of mining machinery. To illustrate that, in the *St. James's Gazette* of that evening, there was a paragraph with regard to the Linares lead district in Spain. It was stated that in consequence of the great increase of lead mining, the Belgian manufacturers had supplied a large amount of machinery, the result of which had been that they had been called upon to supply machinery likewise, for the oil industry of the district, and the people there were giving up the old clumsy wooden presses, adopting improved machinery, and turning out a better article in olive oil. That supported what he had stated in the paper, that they should be justified in looking at the collateral advantages which would undoubtedly arise, apart from any mining results. The evidence of practical men showed that there was a great gold region in Southern India, and nothing but the grossest imbecility could prevent very large results being obtained.

The Chairman moved a vote of thanks to Mr. Hyde Clarke, which was carried unanimously.

Some specimens of gold were kindly lent for exhibition at the meeting by the Wynaad Company, Professor Tennant, and Mr. Bryce Wright.

ELEVENTH ORDINARY MEETING.

Wednesday, February 16th, 1881; W. H. Hall in the chair.

The following candidates were proposed for election as members of the Society:—

Branston, F. R. E., 23, St. Swithin's-lane, E.C., and 66, Lillieshall-road, S.W.
Dollman, Charles, 293, Clapham-road, S.W.
Greenwood, A., LL.D., Flaxfield College, Basingstoke.
MacCallum, Andrew, 47, Bedford-gardens, Kensington, W.
Wilding, Samuel P., 23, Rood-lane, E.C.

The following candidates were balloted for, and duly elected members of the Society:—

Bridge, John, F.R.G.S., Marlborough-house, Sale, near Manchester.
Cochrane, Vice-Admiral the Hon. Arthur A., C.B., United Service Club, S.W.
Collingwood, Lieut. William, The Limes, Cheshunt, Herts, and India-office, S.W.
Fisher, John, 43, Mincing-lane, E.C.
Hall, William Shippery, 79, Cannon-street, E.C.
Haslam, Alfred Seale, Duffield-road, Derby.
Helder, Augustus, Corkicle, Whitehaven.

The Chairman, in introducing Mr. Taylor, said his only title to preside was his having had the good for-

tune to bring to light afresh the most remarkable instance of industrial partnerships—that of Mr. Leclaire, on which a pamphlet, written by him, had just been published by the Co-operative Wholesale Society. The remarkable feature of that enterprise was that, nearly 10 years after the founder's death, it still went on in a more flourishing way than ever. It was the whole object of Leclaire's life that the scheme should not be dependent upon him, and, during the latter part of his life, he withdrew as much as possible from the active supervision of the business. The success had been most wonderful, and the same principle had been followed in several other instances on the Continent; but, unfortunately, in England such attempts had not hitherto turned out well. Many might remember the attempts of Messrs. Briggs, Messrs. Fox, Head, & Co., and others, but they had not the elements of durability. Why this should be so, he was at a loss to understand, because the system was one which eminently commended itself to common sense or enlightened self-interest. Leclaire began life as a labourer, and noticed the wasteful habits of labourers. As he got on in life, and became an employer himself, he asked himself the question if nothing could be done to remedy this state of things, and came to the conclusion that the only way was to give the workmen themselves an interest in greater thrift, carefulness, and industry. He thought that if 6d. a day was saved in this way, and the workmen received 1½d. of it, and the employer 4½d., the plan could be adopted, and this proved to be the case. In this way a large fund was accumulated out of nothing. He had a suspicion that one cause of the non-success of the plan in England, was the opposition of trades unions. These organisations had done great good in some respects, but he feared that in some cases they had opposed enterprises of this kind, which had been essayed by men not in the union, and of which the union leaders were jealous, because they were not concerned in it themselves. He threw out the hint that this might be the cause, because he knew that in France, employers came more directly in contact with their workpeople.

The paper read was on—

THE PARTICIPATION OF LABOUR IN THE PROFITS OF ENTERPRISE.

By Sedley Taylor, M.A.,

Late Fellow of Trinity College, Cambridge.

I ask attention this evening to a particular method of remunerating labour, which has for some time been practised in a large number of important industrial and commercial establishments, situated for the most part in France, Switzerland, and Germany. If any justification is needed for bringing this subject before the Society of Arts, I find it in the following considerations:—The relations between employers and employed, under the system of payment by fixed wages only, are admitted on all hands to be unsatisfactory. They involve a chronic antagonism, breaking out periodically into internecine conflicts, which leave few tangible results behind them, save extreme mutual exasperation. One is reminded of the old schoolgame of French and English, where a great expenditure of force in tugging at the opposite ends of a rope has for chief result a marked rise of temperature, where in fact, as in an ill-constructed machine, energy is converted mainly into heat.

The evil of a permanent antagonism between men engaged in one and the same branch of production or distribution, has induced a number of employers to try whether by modifying the established method of remuneration by wages only, they could bring about a better state of things. The bulk of these experiments have been made on the Continent, and, though not without examples of failure, they present, on the whole, a very decided and very encouraging success. This being so, the close connexion which links together the industries of neighbouring countries makes it incumbent on English employers to bestow vigilant attention on a matter of such importance as a considerable continental movement towards a reform in the mode of remunerating labour.

While, however, I feel that the nature of my subject is its own best justification, I am perfectly aware that one who, like myself, is no employer of labour, and, consequently, has no profits to divide, may, when he urges such division upon those who have, be damagingly compared to a certain hearer of a charity sermon, who, according to Sidney Smith, found his generous emotions so stirred by the eloquence of the preacher, that he put his hands into his neighbour's pockets, and was thus enabled to place a most liberal contribution in the plate. In order to avoid the point of this dangerous comparison, I shall, without professing an impartiality which I do not feel, endeavour, as far as possible, to set out the facts on which I rely, in the statements, often in the actual words, of employers describing the results of experiments which they have themselves made. By placing before you their statements in the most authentic and least warped form at my command, I hope in some measure to make up for my own lack of business knowledge and business experience.

The mode of remunerating labour which is now to engage our attention consists in assigning to the employed, over and above their wages paid at the ordinary market rate, a part of the net profits realized by the concern for which they work. The system is known in France as "*la participation aux bénéfices*," *i.e.*, participation in profits. I shall, for shortness's sake, designate it in this paper simply as "participation."

The economic basis on which the method rests may be thus stated:—The profits realised by an industrial establishment must largely depend on the degree of vigour and vigilance with which the hands in its employ perform their work. Economy of time, and avoidance of needless consumption of raw materials and destruction of tools and machinery, will lead to higher profits than can accrue where dawdling, waste of materials, and recklessness in handling implements and gear are the order of the day. Now, the established practice of the workshop shows that, under the system of payment by wages alone, it is not expected that this zealously active type of work will be given voluntarily. Watchers and overlookers are placed there, in order to extort, by the fear of dismissal, whatever quantity and quality of work is obtainable by an appeal to such feelings.

Work thus reluctantly yielded will, manifestly, be inferior at all points to that given voluntarily. It will therefore be dear work, and tend to shorten profits, which will be further preyed upon by the wages of the overlookers employed in exacting it, in other words, by the "costs of superintendence" which it entails. The expectation of those who

introduced participation was that, under that system, work of the most zealous kind would be spontaneously given, when once the workmen had become fully alive to the fact that their more efficient efforts would directly benefit themselves. Thus better, and therefore cheaper, work would be obtained, and the costs of supervision be proportionately reduced. It is in the additional profits to be realized by these stimulated efforts, and in the economy in superintendence which they render possible, that participation finds the fund which it promises to divide. The employer is, therefore, not called upon to forego any portion of the profits which would, under a non-participating system, have accrued to him.

In regard to the manner in which the workmen's share in profits is made available by them, there exist among participating houses very wide differences of practice; indeed, these differences afford a convenient means of classifying such houses. They fall into three categories:—

1. Those which pay over the workmen's share in an annual ready-money bonus.

2. Those which retain that share for an assigned period, in order ultimately to apply it, together with its accumulated interest, for the workmen's benefit.

3. Those which annually distribute a portion of the workmen's share, and invest the remainder.

I propose to take one establishment out of each group as a type-specimen. It will be readily understood that limits of time will compel me to describe their organization only in the most general terms.

In regard to the sources from which my statements of fact will be drawn, I can here only name summarily the chief. These are:—(1) A German work, published in 1878, by Professor Böhmert, of Dresden, under the title "Die Gewinnbetheiligung,"* or "Division of Profits." (2) The periodical *Bulletin*† of a French society, formed in 1879, for facilitating the practical study of participation, and (3) the work of M. Fougerousse, "Patrons et Ouvriers de Paris,"‡ "Masters and Men in Paris," published in 1880.

Quitting preliminaries, I begin with the group of houses which hand over the workmen's entire share of profits in annual ready-money bonuses. I take as type-specimen the establishment of M. Bord, pianoforte maker, 64, rue des Poissonniers, Paris. Participation has existed in that house since 1865, on the following basis:—At each annual settlement, interest at 10 per cent. on the capital invested in the business is deducted and handed over to its proprietor, M. Bord. The remaining net profits are then divided into two parts, respectively proportional, the one to the interest already allotted to capital, the other to the whole amount which has been paid during the year in wages at the current market rate. The former part is added to M. Bord's receipts; the latter is divided among all such workmen as have been employed by the house for not less than six months of the year in question. The individual distribution takes place in bonuses proportional to the yearly sums respectively earned by each workman in wages. These dividends to labour are handed over without any limitation or condition whatever. The number of *employés* was, on January 1, 1878, 6 clerks, 395 men, and 27 boys. The sums thus paid during the last three years were, I am informed by M. Bord, in 1878, £3,784; in 1879, £2,874; and in 1880, £3,548. They represent, respectively, 15 per cent., 12 per cent., and 16 per cent. on the men's yearly earnings in wages. The entire amount paid over, exclusively out of profits, since the introduction of participation in 1865, is £39,300. M. Bord considers the effect of the system, in attaching the workmen to the house, and its influence on their relations towards their employer, to be extremely satisfactory. In June, 1869, he ascertained that about one-half of his workmen had invested their dividends for that year, and that about a quarter had employed them in clearing off debts, and in purchasing clothes and furniture. A dozen or so only had dissipated a part of their dividends.

* Leipzig, Brockhaus. † Paris, Chaix. ‡ Paris, Chaix.

The number of houses which adopt M. Bord's system of immediate cash distribution is very small. I pass to a larger group, organized on a very different plan. The example selected is a leading Parisian Insurance Company, the Compagnie d'Assurances Générales, 87, rue de Richelieu.

In this company, whose staff of officials, clerks, and other *employés* numbers about 250 persons, participation is now of thirty years' standing. It is fixed at 5 per cent. on the profits of the company, and allotted in proportion to the individual salaries earned, which are at least on a level with those obtainable in non-participating companies of the same kind. The essential feature of the system here in force is that no part of an *employé's* share in profits is paid over to him in ready money. The sums to which he becomes yearly entitled are placed in a deposit-account opened in his name, where they accumulate at 4 per cent. compound interest. Only on the completion of 25 years of work in the house, or of 65 years of age, can the beneficiary claim the liquidation of his account. The following alternatives are then at his choice:—He may purchase a life-annuity in the company's office, with reversion to his widow or some other person to be approved by the Board of Directors; or he may invest in French Government or railway securities, in which case the stock certificates will be retained by the company until his death, in order to be subsequently handed over to the persons whom he may designate by will as his heirs. He cannot claim the payment of his account in ready money, the Board of Directors being sole judges of the exceptional circumstances under which they may consent to such payment, and not bound to assign any reason for their decision.

M. Alfred de Courcy, to whom the Compagnie d'Assurances Générales, of which he is the managing director, owes this particular form of long-deferred, indeed, one may say, of testamentarily transmitted, participation, has publicly advocated it with great eloquence and ability. He insists on the relatively large sums which it has accumulated, in comparatively short spaces of time, for *employés* of the company. Thus he specifies a simple bookkeeper, in whose name £480 stood to the good after fourteen years of work, a sub-cashier with more than £800 after 25 years, and a superior official with £2,600 at the end of a similar period. The results to the company itself are described in the following passage, which I

translate at second hand, from the German version of the original given by Böhmert:—

"The bond which unites the company and its *employés* has acquired a peculiar strength. Formerly, notices of resignation were very numerous. Among the young people, caprice, levity, and infirmity of purpose were often the cause of this. On the occurrence of the slightest annoyance they became intractable, and withdrew, or worked negligently, while they were looking about for another post. In the case of the more practised and experienced *employés*, personal interest was the decisive motive. New insurance companies were called into existence, the founders of which naturally sought for people who were not novices, and possessed special acquaintance with our business. Where were such men to be found, unless in the staffs of the old insurance companies? We, therefore, frequently had our best *employés* carried off by the promise of a higher remuneration, in order that they might make use elsewhere of the knowledge acquired with us, so that we actually furnished the weapons for a competition directed against ourselves. To this disorder, and this withdrawal of *employés*, which threatened to injure our organization, the deposit-account has put an end. It is so highly valued, that the sacrifice of the benefits of participation for a momentary advantage is not readily made. It has rendered even the young people more steady and assiduous. The faithful *employés*, too, have become more hardworking, not merely because they know that they have a joint interest in the success of the business, but because it is an advantage for them that the number of the staff should not be increased. At the time of heavy pressure of business they are, therefore, willing to redouble their activity, and, if necessary, to stay over-hours at the office. Their own interest is the best guarantee for their zeal. The limitation of the number of *employés* to what is adequate, and no more, is an important source of saving to the company."

M. de Courcy is so high an authority on all matters connected with participation that I desired, for the purposes of this Paper, to ascertain his latest view on the subject. I accordingly asked him to tell me whether his opinion, both of the principle of participation itself, and of the system of deferred possession, remained as favourable as at the time of the publication of Professor Böhmert's work. In his reply, dated November 6, 1880, M. de Courcy writes as follows:—

"My present opinion is more favourable than ever, both to the principle of participation, and in particular to my system of deferred possession. The institution has now had thirty years of experience, that is to say, of unvarying successes. Each year, by augmenting the account of the *employé*, makes him feel more strongly the advantage of the deferred participation. Each year, too, the company appreciates better what it gains in fidelity in return for these sacrifices. My general principle is that there are no thoroughly satisfactory business transactions except those which are satisfactory to both the parties concerned. Experience has justified our institution from each of these points of view. It is excellent for the *employés* and excellent for the company."

The great majority of participating houses have favoured neither the entire immediate distribution of profits practised by M. Bord, nor the extremely remote postponement of benefits advocated by M. de Courcy. They have adopted a mixed system, by conceding to the workman immediate possession of a part of his share in profits, and investing the remainder for his future benefit. Of the establishments which have taken this course, I select as example the great railway printing, publishing, and bookselling house of M. A. Chaix, 20, rue Bergère, Paris, who is at once the "Bradshaw" and the "Right Hon. W. H. Smith" of France, and who employs about 600 persons of both sexes. Participation dates from 1872, and extends to all well-conducted hands who can show three years of continuous presence in the house. The share assigned to them is separately fixed each year, but has hitherto been 15 per cent. on the net profits. The sum allotted to each participant, which is proportional to his or her annual earning in wages, is divided into three equal parts. One of these is handed over on the spot in cash; a second, though regarded as the property of the recipient, remains in the custody of the house, in order to aid in supporting its provident society; the remaining part is likewise placed to the credit of the beneficiary, but only comes into his possession at the age of sixty, or after twenty years of uninterrupted work for the house.

In regard to the ultimate disposal of the second and third parts, regulations subsist similar to those in force in the Compagnie d'Assurances Générales.

The total amount allotted by M. Chaix out of profits to his participants, from 1872 to 1880, is £14,409, which represents an annual average of 7½ per cent. on the wages of the beneficiaries. Only one-third of this average, *i.e.*, 2½ per cent. on wages was, however, as has been already explained, yearly distributed in ready money. In regard to the general results of participation in this house, we have the testimony of M. Chaix himself, in the addresses which he has delivered to his participants at each of the seven yearly distributions which have as yet taken place.

I will translate a few extracts from these, which speak for themselves.

At the second participation, on April 5, 1874, M. Chaix said—

"I have ascertained with satisfaction that the introduction of participation has, as I hoped it would do, developed the zeal of those interested in it; each one takes more interest in the work assigned to him, and executes it better and more expeditiously."*

On March 28, 1875, he spoke as follows:—

"If there be a spectacle which should satisfy the friends of social peace, it is assuredly that presented by the industrial family of this establishment, when, at the completion of the year's work, it is gathered together in order to learn the results of its own allotted share in the profits realised. No institution is, indeed, better adapted to draw close the bonds which unite you to the house, and to inspire you with confidence in the future, than the participation which has enabled me to constitute for your benefit, not only certain immediate advantages, but also an economized capital, which has, for some among you, already reached important dimensions."†

The address of April 13, 1879, contains the following passage:—

"In what concerns the execution of work in the workshops and in the offices, I find around me such an amount of willing zeal, that I give the main credit for this excellent state of things to participation, and congratulate myself more and more on having set that principle working in the house."‡

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* Comptes Rendus des Assemblées Générales Annuelles. Paris, Chaix, 1880, p. 33.
† *Ib.*, pp. 39 and 40.
‡ *Ib.*, p. 73.

The three categories, of each of which an example has now been given, include all houses practising what has been termed simple participation, *i.e.*, that under which the participants are allowed no voice in the administration of the concern for which they work, and own no part of the capital embarked in it. There are, however, a few houses which admit their workpeople to partownership in capital, and to a share in administrative control. These establishments are specially interesting, not only on account of their individual importance, but because their organization may be regarded as marking the point of transition from simple participation, where the master retains exclusive possession of capital and control over direction, to co-operative production, where the entire capital belongs to the associated workmen, and the business-direction is in the hands of a manager or committee acting under their authority. Each of the small group of houses occupying this intermediate position is well worthy of special study, but where, as this evening, but one of them can be described, the Maison Leclaire, at Paris, is incontestably entitled to be selected as the representative of the group. It is a house-painting and decorating establishment, 11, rue Saint-Georges, and employs at present upwards of one thousand workmen. Its founder, born in 1801, the son of a poor village shoemaker, and apprenticed in 1818 to a Parisian house-painter, had, by 1834, already attained a position of distinction and assured success as an employer of labour in that branch. From 1842 onwards, he practised participation in profits, beginning with his steadiest and best-conducted workmen, and gradually extending the system among the others. In 1853, Leclaire established, for his workpeople, a "Mutual Aid Society," to be supported exclusively out of the profits of his house. This society which, until 1860, only performed the functions of an ordinary sick-club, undertook thenceforth to supply retiring life-pensions to its members on their superannuation from active work. In 1864, the same society was, by formal and irrevocable deed, constituted sleeping partner in the house, and owner of a considerable portion of its capital. Five years later, in 1869, Leclaire took the final step of transforming his establishment into a permanent industrial Foundation, the net profits of which, after deduction of 5 per cent. interest on capital, were to be annually disposed of in the following proportions:—One-fourth was to go to the two managing partners, who were at first to be M. Leclaire himself and his associate, M. Defournaux. One half was to be distributed in ready-money dividends to labour, and the remaining quarter to be handed over to the Provident Society for its sickness and pension fund. The business-direction of the house, *i.e.*, its actual executive, was to remain exclusively in the hands of the two managing partners for the time being. To the full members of the Foundation were, however, reserved very considerable powers, to be exercised by them through two committees, one for the "House," the other for the "Society," on both of which labour would have a predominant representation. These two bodies, with their electing constituencies, were to choose the managing partners and foremen, admit new members, expel grave misdemeanants, administer the funds of the "Society," and see that the share of profits annually due to it from the "House" was fully paid over.

Leclaire did not long survive the definitive incorporation of his house. He died in 1872, and in 1875 death removed his successor, M. Defournaux. The present heads of the establishment are MM. Redouly et Marquot, the latter of whom was private secretary to Leclaire. M. Charles Robert, *conseiller d'état* under the Empire, who from his boyhood was strongly attached to the founder, succeeded him as President of the Mutual Aid Society, and, though now charged, as managing director of a great Parisian Insurance Company, l'Union, with engrossing administrative work of his own, has never ceased to be the staunch and untiring friend and counsellor of the Maison Leclaire; advocating its central principle with a ready pen, and standing forth, with eloquent tongue and cultured utterance, as its mouthpiece on every occasion of corporate weal or woe, whether to cheer on its members with the good news of continued and increasing prosperity, or to pronounce in their name, as they crowded in hundreds around him, words of final leave-taking at the open graves of Leclaire and Defournaux.

The material successes achieved by the house during the last ten years have been little short of marvellous. The sum paid each year in wages has increased during that period from £16,257 to £34,715; the sum annually paid in labour-dividends out of profits has risen during the same period from £2,331 to £6,400. In other words, the yearly payments in wages are now double, and the workmen's ready-money receipts out of profits nearly treble, what they were ten years ago. Each individual participant received, at the distribution made last summer, more than 18 per cent. on his year's wages.

Independently of these annual immediate advantages, the Mutual Aid Society assures to each of its members, besides all the benefits of an ordinary Friendly Society, a life-pension of £40 per annum from his fiftieth year of age and twentieth year of work in the house, half of which is continued to his widow for her life. It further pays over an additional £40 in cash at his death to his survivors, and, if he is disabled or killed while on actual duty, pensions him off with the full life annuity of £40, or his widow with a half-pension of £20, and that however short may have been his period of service in the house. The purely economic results of participation in the Maison Leclaire may be summed up by saying that the total of payments out of profits to the participating workmen, since 1842, whether made in ready money or to the account of the Mutual Aid Society, has now reached the sum of £94,700.

I wish the time at my command permitted me to describe, even in the briefest terms, the high educational and moral benefits flowing from the administrative and social institutions which Leclaire grouped around the central principle of his Foundation. I abstain, however, with the less reluctance, inasmuch as a somewhat full account of these institutions is to be found in the *Nineteenth Century* for September, 1880.

The principle of participation, organized under a

great variety of different forms adapted to differing industrial conditions, has been applied with success to almost every class of undertaking, productive, distributive, or purely administrative. In order to give an idea how large is the extent of ground covered by these applications, I will refer, very summarily, to a few leading categories.

In agriculture, undertakings on a participatory basis are being successfully carried on by Herr Von Thünen in Mecklenburg, by Herr Neumann in East Prussia, and by Baron Zytphen-Adeler in the Danish island, Zealand.

In production on a considerable scale, I may cite the paper-mills of M. Laroche-Joubert, at Angoulême, which employ 1,500 workmen; the Maison Leclaire, with its 1,000 or 1,100 painters and decorators; and the cotton-mills of Steinheil et Compagnie, at Rothau, in Alsace, which give employment to some 600 men.

Of productive establishments working on a smaller scale, a conspicuously successful example is the firm Billon et Isaac, at Geneva, which manufactures parts of the mechanism of musical-boxes, and employs about 100 workmen.

Under distribution, a leading house is the Magazin "au bon marché" at Paris, property of Madame Veuve Boucicaut, a huge establishment for the sale of manufactured articles of all kinds, which allots a share in profits to about 300 out of the 1,600 persons whom it employs. There are, especially in Paris, very many smaller participating establishments, in different branches of distribution, which it is needless to refer to by name here. In order, however, not to pass over the purely administrative undertakings, I may instance the bank of Vernes et Compagnie at Paris, and a whole group of insurance companies in the French metropolis, including, beside the Compagnie d'Assurances Générales already referred to at some length in this paper, l'Urbaine, l'Aigle et le Soleil, la France, la Nationale, and l'Union.

The whole number of establishment now at work on the Continent upon a participatory basis, does not admit of exact determination, but is certainly not less than one hundred.

I have as yet mentioned cases of successful participation only, and an earlier reference may have been expected to the abortive attempts which have occured on the Continent side by side with the prosperous experiments described above. In particular, I may be fairly asked to explain why I have said nothing about conspicuous English experiments, which have ended in the abandonment of the system. Now, assuredly, it has been from no desire to blink discussion of the English cases that I have abstained from entering upon them here. On the contrary, I think that instances of failure are often precisely those which best deserve and reward a searching discussion.

In order, however, that such a discussion may take place to any good purpose, it is an obviously essential preliminary that the facts on which the failure turned be publicly accessible, in detailed statements of recognised authenticity. In regard to the unsuccessful English experiments, this condition has not been satisfied. The circumstances which brought about the abandonment of the attempt have formed the subject of no detailed and authoritative public statement. As far, indeed, as concerns one of the most important and best known unsuccessful English experiments, that made from 1865 to 1874 in the collieries of Messrs. Briggs, at Whitwood, I have reason to believe that a statement as to the causes of the failure is likely before long to be forthcoming, under the authority of Mr. Henry Currer Briggs. At present, however, the basis for a decisive discussion of the abandoned English attempts is non-existent. With regard to the continental break-downs, we are, thanks to Böhmert's research, in a better position for forming a judgment. Lack of time alone prevents my entering here on these cases, in respect to many of which the failure can be decisively traced to causes extraneous to the principle of participation.

I have now, far more fragmentarily, indeed, than I could have wished, described the main features of participation as practised on the Continent. It remains to say a few words on the system itself, and on its applicability to English circumstances. The theory on which it is based—a theory abundantly verified by experience—is that, by directly interesting workmen in the fruits of enterprise, better and more economical labour will be obtained, and thus a source of additional profits opened. These surplus profits might, indeed, without injustice, be allotted wholly to the workmen whose stimulated efforts produced them. In practice, however, a share goes to the employer, who, if he so pleases, may, by investing it in a reserve fund, protect himself against losses in bad years. It is thus clear that participating workmen do, in an indirect but perfectly real way, share losses as well as profits with their employers. This is often denied by opponents of the system; it is, therefore, important that the fact should be explicitly asserted and made good.

In regard to the final disposal of the workman's share in profits, it will not have escaped notice how all but diametrically opposed to each other are M. Bord's system of annual cash distribution and M. de Courcy's method of long-deferred possession. On the merits of these rival systems an eager discussion took place before the Société d'Economie Sociale, at Paris, in April last.* A question on which two such authorities as M. Fougerousse and M. de Courcy are not agreed, and which a majority of houses has rather compromised than decided, leaves even inexperience free to utter its opinion. I may, therefore, venture to say that the system of immediate cash distribution seems to me alone consistent with the economical theory on which participation rests. The workman's share of profits is earned by his own more efficient labour, and, from the moment of its definitive realization and ascertainment, becomes rightfully his. It can, therefore, be temporarily withheld from him on one ground only, that, in his own interest, and in that of the community, he ought to be debarred from the free disposal of his own earnings.

I cannot believe that, among the steady and energetic class of workmen, with whom alone participatory experiments should, at least at first, be attempted, there is any necessity for such arbitrary restrictions. The greatest pains should undoubtedly be taken to bring forcibly before them, at the time of the annual division of profits, the extreme im-

* "Bulletin de la Société Internationale d'Economie Sociale." Paris, 2, Rue Perrault, 1880. Tome vii., pp. 145-186.

portance of systematic and persevering investment. But the final decision ought, I think, to be left to those who can probably decide better what is for their own interest than other people can settle it for them. As far as English workmen are concerned, there can be little doubt that the strong feeling of independence which the influence of trade societies has fostered among them, would make the compulsory detention of sums actually earned extremely unwelcome, even if it did not, as I think it very possibly might, render such detention impracticable.

Participation, successfully practised under whatever form, confers, as has been seen, signal advantages on both the parties directly concerned in it. To the employer it gives increased security and industrial peace. For the thrifty workman it accumulates, not by the hand of charity, but as the result of his own heartier efforts, an economized capital, which he may employ in making his old days easy and independent, or, better still, transmit, in part at least, to his children. Further, what is of even higher significance, it brings to the workman an enhanced feeling of respect for himself and for his fellows, based on the fact that he and they have become, in a very real sense, partners in the house for which they toil.

It would be an oversight if I omitted to point out here the advantage which the public too, in its capacity of consumer, derives from the system before us. Participation encourages excellence of workmanship, and combats every form of trade dishonesty with singularly efficacious vigour. The very intensity of the complaints so constantly made of the procrastinating, scamped, ungenuine work performed under existing industrial arrangements, is a measure of the benefits to the consumer to be looked for from a system under which these evils are, on mere considerations of self-interest if on no higher ground, sternly discountenanced by the workmen themselves.

I have now only to ask, in conclusion, whether there is any valid reason why a system which has proved so fruitful in good results on the Continent may not be hopefully re-introduced into this country? In order to answer this question, we have only to take two preliminary steps; to set out the economic conditions under which a participatory success is attainable, and to examine whether those conditions can, or can not, be satisfied in England.

In order that participation may be advantageously introduced in any particular branch of industry, the workmen must have it in their power, by more efficacious labour, to increase the quantity, improve the quality, or diminish the cost price, of the staple of production in that branch. The extent to which these results are attainable—the purchase which manual labour can thus exert upon production—must necessarily be different in different industries. Much will depend on whether the materials employed are cheap or costly, and on whether machinery plays a subordinate or a predominant part in the production. The degree in which costs of labour-superintendence admit of being reduced, is also an important element of the question. A promising field is, therefore, manifestly presented by such industries as house-painting, papering, glazing, plumbing, &c., in which manual labour plays the predominant part, and individual superintendence is well-nigh impracticable, and where no one will have the hardihood to assert that the workmanship is already of so zealously active a type that its excellence is unsusceptible of further improvement. Much the same may be said of agriculture. In coal-mining, as I am assured by the most competent witnesses, there occurs a huge waste of materials, due solely to the fact that the colliers have no interest in preventing it. Even in machine-dominated industries, the vigilant attention with which a really zealous operative superintends the instruments under his charge has a surprising influence on the final result. Mr. Kenward, the very able manager of the lighthouse department of Messrs. Chance's glass-works, near Birmingham, where the prevalence of piece-work supplies a direct gauge of the results attained by individual effort, assured me that, in such an apparently routine occupation as superintending a machine punching holes in a metal plate, a thoroughly active workman could realize a surplus wage three times as great as that obtained under identical conditions by a less strenuous, but not less skilful or less capable, colleague. At a meeting in Birmingham, attended by representative artizans, it was asserted without contradiction, by an exceptionally well-informed man, that "an enormous preventible waste occurred in every trade in the town."

It would appear, from the above considerations, that there is no lack of scope for participatory successes in many branches of English industry. The question may, however, be raised—Can our workmen be brought to recognize the benefits of participation, and put forth the sustained and intelligent efforts which can alone ensure the successful working of that system?

On this issue the rapid spread among the working class of education, and of the feeling of mutual confidence which all genuine education fosters, may well relieve us of serious hesitation. No one who has marked the eager interest which men of that class now take in social questions; or who, like myself, has seen hundreds of colliers in regular attendance at a course of systematic lectures on Political Economy, delivered week by week for three months on end, by a popular, but none the less thoroughgoing, exponent of that subject,* can entertain a doubt that participation in profits, if once clearly set before the working classes of this country, will soon be thoroughly understood and appreciated by them. My own very decided conviction is, that participation has a great future before it in this country; and I am strongly confirmed in that view by the opinion of the leading French exponent of the system. Writing to me on Nov. 8, 1880, M. Charles Robert expressed himself in words which I translate as follows:—

"Wherever there exist in combination industrial

* Mr. W. M. Moorsom, of Trinity College, Cambridge, delivered, in the autumn of 1880, a course of 12 weekly lectures on Political Economy, to audiences consisting chiefly of pitmen, at five centres in the Newcastle coal district. The lectures were organized under the University of Durham extension scheme; and at one exclusively mining centre alone, 400 tickets for the entire course were sold in advance. "No public speaker," writes Mr. Pringle, of Barrington Colliery, Northumberland, "ever took away from our remote county so large a share of good wishes and heartfelt gratitude, nor left behind him such a popular name as Mr. Moorsom."—See *The Common Good*, Jan. 15, 1881, p. 239. Published at 282, Strand, London.

energy, intelligence, and the spirit of initiative, the final success of generously-conceived innovations is almost always assured. And where is a greater and better success to be looked for than in England, the country of personal independence, and of combined effort, the classic land of free and fruitful activity, whose denizens are accustomed to mass their individual powers, and to serve as models to every student of the theory and practice of association? The admirable results obtained on your side of the Channel by Co-operative Societies of Distribution, the magnificent development of your Friendly Societies, the formidable power of your Trades' Unions, prove to demonstration that England will well know how to make participation in profits prosper within her borders. English advocates of that system will assuredly obtain a favourable hearing, as well from industrial chiefs as from workmen, and I make bold to hope that we in France shall soon be called upon to register their successes, and profit by their examples."

Before sitting down, I desire to make a practical suggestion to which I attach considerable importance. It is manifest that before participation can be extensively tried in this country with good prospects of success, the results attained on the Continent must first have been adequately studied both by English employers and by English workmen. Now, what are the means as yet provided for pursuing this study? In the spring of 1879, a society composed of employers engaged in industry or commerce was established at Paris, having for its sole object to facilitate the practical study of participation in profits. This society has already published in its periodical *Bulletin* the regulations of the most important participating houses, and has assembled in its library a mass of unpublished rules in force in the less conspicuous establishments. It is now bringing out in a French translation, with the author's latest additions, the work of Bohmert, which is a real mine of trustworthy information, particularly as to results obtained in Germany. Clearly, therefore, an inquirer who wishes to make a practical study of the subject may derive the greatest assistance from the French society. He finds abundant matter in its publications, and, should he desire further information on points of detail, has only to place himself in communication, through its officers, with the heads of houses abroad whose systems he may desire to investigate. But these facilities are as yet restricted to students possessing a good knowledge of French, and a not inconsiderable stock of leisure. In order that they may be effectively thrown open to all classes in this country, means must be taken for publishing, in plain readable English, and at a low price, the most essential facts which have been ascertained by continental research. The work might well be undertaken by a special society, which should endeavour to facilitate in England the practical study of participation, whose objects and whose title should, in fact, be identical with those of the French society. Such an association would disseminate trustworthy printed information, promote the reading of papers, the delivery of lectures, the holding of discussions, and generally seek, by every available means, to spread sound knowledge on the subject with which its operations were concerned. It would also serve as a bond of union and mutual support between such English houses as gave an actual trial to participation, and between all persons interested in the progress and development of that principle. A very important feature of its work would obviously be the maintenance of close and cordial relations with the French society, and with the heads of the movement in other parts of the Continent.

In order roughly to gauge the amount of support likely to be forthcoming for a scheme of this kind, I should be very pleased to receive, at Trinity College, Cambridge, the names and addresses of any persons, whether occupied or not in industrial or commercial pursuits, who, were such a society to be called into existence, would be disposed to join it.

DISCUSSION.

Mr. Wolstencroft felt sure that the scheme might be applied with success to many industries, but that in others, piece-work would be superior. He gave several instances where double the amount of work was done with the same number of hands on piece-work, and at much less expense to the employer. He did not think the system of participation would be applicable to collieries. There the workings were let out in drifts to a man, who was paid so much a ton for all the coal which came out of the drift. He was not paid for the dirt, but only for the amount of coal raised, and a higher price for that raised in good condition. In Oldham the co-operative system was commenced, and was found to answer very well, one mill paying a dividend of 25 per cent.; but, in consequence, there was a rush of capital into this industry, and 20 large mills were built at one time, some containing about a quarter of a million spindles, and then the market became glutted. Participation might readily be applied to warehouses where the work could not be placed on the piece-work footing; but generally he maintained that it was best to pay men by results.

Mr. Lloyd Jones suggested that it would be better not to discuss the disputed question of piece-work or day-work. Before dealing with the question, he wished to correct the Chairman's statement, that the trades unionists of the country were adverse to proposals for a participation of labour and profit. He was not aware that such was the case, and he had perhaps as large an experience of trade unionists as any man in the country. He knew all the leaders in every branch of industry where trade unionism existed, and he did not know a single case of personal hostility to such a scheme. He knew that Mr. Briggs had not succeeded with it, and no doubt that gentleman had many grievances, which he would make known when he published his statement; but there was quite another side to the question, which it would be time enough to deal with when Mr. Briggs had published his statement. Nothing could be more interesting than such a subject as that now brought forward, if for no other reason than that it was absolutely impossible that the present industrial system of this country could go on. He joined trades unionism 53 years ago, and had been in intimate connection with members of various trades unions from that day to this, and he was more satisfied than ever that the system on which business was now conducted would absolutely break down unless interests which were antagonistic could be reconciled. The partnership spoken of would answer where you got a man of large intelligence and benevolence, who undertook to do the work in which he called his workmen to assist him, and where the workmen were absolutely satisfied as to the intentions of the man who called on them to co-operate with him, but there was nothing more certain than that where suspicion of the employer by the employed came in, the whole thing would break down. He did not agree with

the reader of the paper where he spoke of the break down of the attempts at co-operative production in this country.

Mr. Taylor said he did not speak on co-operative production. His remarks were exclusively limited to industrial partnership.

Mr. Jones said he had alluded to Mr. Briggs' scheme, which consisted simply of a bonus given by the vote of the shareholders at their half-yearly meetings, the workpeople being entirely at the control of the shareholders. The shareholders voted according to what they thought it was right to give, and the workpeople found themselves gradually cut off until their bonus entirely disappeared. He would say further, that the workpeople felt all along that a portion of the design of that experiment was to draw them away from the trades unions to which they belonged. Now, there were a number of gentlemen present who were engaged in the work of distributive co-operation, and the workmen connected with that had in their hands what they called the organisation of the custom of the country. The business they were doing was, perhaps, £14,000,000 or £15,000,000 a year. They had, therefore, in their hands the orders from all people belonging to these various stores, and, having those orders, they could regulate production precisely as it suited their purpose. Instead of manufacturing speculatively, as most manufacturing was carried out, and at a very serious loss occasionally, they manufactured in reference to the custom which they had organised. Thus the demand came before the supply, and the fatal point in the present system, where you overdid the supply of any given article, and therefore reduced its market value, and ruined profits, as had been the case in the coal industry, was avoided. In this way they produced a scientific relationship between the supply and the demand. The co-operators had established a place, not referred to in the paper, at Leicester, called the Leicester Boot and Shoe Works. Sometimes they did not make heavy profits, because they foolishly competed with the outside market, when there was no absolute necessity to do so. Here there was no speculation, and no fear of loss which they did not wilfully bring upon themselves, and the demand and supply was brought into a kind of harmony, which prevented the bankruptcy and ruin so common in trade. He believed that if employers would put themselves into friendly relationships with their *employés*, they would hit upon some plan of running side by side without injuring each other, and bring out of the industry of the country fair wages for one, and fair profits for the other.

Mr. Sillar said it ought not to require many words to satisfy anyone of the advantages of the participation of labour. It was proverbial that carelessness was common. He used the word in no offensive sense, but simply as the absence of care. Anything which could identify the interests of the labourer with his labour was certain to result in good. If, therefore, it was very good to allow labourers a little participation in the profits, it would be better to allow them to have more, and best of all, if such a thing could be arranged, that their interest in it should be entire. The chief difficulty that appeared to crop up, was that there were three kinds of labour; constructive labour, destructive labour, and distributive labour, and it was a very difficult thing indeed to say what proportion of the profits of destructive labour should fall to the labourer. The result of labour, until it was ascertained, was an unknown quantity, and in that unknown quantity, it was quite right that the labourer should participate, and have an equal share of it as a remuneration for his contribution to bring it about. But, unfortunately, the labourer could not wait for the harvest; he generally lived from hand to mouth, and, therefore, he sold his day's labour at the market rate, and the market rate was the estimate which somebody else formed of what the result was likely to be. Wherever the result was likely to be very prosperous, a man would willingly pay double for the labour. If therefore, the reader of the paper, instead of saying the labourer was to share in the profits of industry, said he should share in the results of the industry, it would present the question in a very different aspect. There were very few labourers indeed who were prepared to stake their daily bread on the results of their industry. In fact, in these days, we had too many instances where combined industry was most disastrous. If the wages were not equitable, the man ought to get more; but the capitalist would only pay the market rate, which fluctuated like the market rate of anything else. In England, we had instances of that sort of co-operation on a large scale. One instance was the old East India Company, where, originally, the dividends of the shareholders were limited to 10 per cent., and, consequently, they had no other field for disposing of their surplus profits than in raising the wages of their *employés*. These were raised to such a grand sum that they commanded the very finest industry and talent of Great Britain. The system, as carried on at the India-house, closely resembled that described in France. Part was paid in the shape of wages, and part in the shape of bonus or retiring allowances. It would be a grand thing for every labourer if he were entitled to a retiring pension at a certain age; but very few would like to trust their employers with such an amount for 30 years; and he certainly should prefer to get it in cash, and to put it in some insurance office, in which he had more confidence.

Mr. Ganney agreed with Mr. Lloyd Jones that the industrial system of the country must be changed. As one of the Society of Arts reporters at the Paris Exhibition, he had some opportunities of observing from different standpoints the position of labour on the Continent as compared with England; and he had spent some years in America. He had noticed there that employers would cheerfully pay dollars a day and succeed, where an English employer would scarcely pay shillings and fail. The fault lay very much in this, that there were not sufficient competent employers; the men who directed the large industries of the country in many cases not being practically acquainted with the business they carried on. In old days, the men who built up the trade of England were actual workers, but now he knew a series of trades which were being positively annihilated by foreign competition, for instance, the English clock and watch trade, in which men now made money by putting the London trade-mark on foreign articles. That was a state of matters for which he long worked to find a remedy, and he trusted that the direction in which the reader of the paper was working, viz., the practical co-operation of the workmen with competent employers, would lead to a solution of the difficulty. He had made attempts to introduce the co-operative system, both in London and in Coventry, but in neither case had they been successful, on account of the inability of the workmen to find sufficient capital when trade was in full swing. If they could only get large capitalists to induce practical workmen to take an interest in their business, many trades which were now languishing on account of the antagonism between the capitalist and labouring classes, would revive, and increase to an extent which few could conceive.

Mr. Chapman regretted that the reader of the paper had not called attention to the speech of the Emperor of Germany, which appeared in that day's papers, in which he alluded to the scheme brought forward by Prince Bismarck for improving the condition of the proletariat. That scheme, as published in the *Spectator* for January 5th, consisted in making assurance against accidents compulsory in some branches of labour, half the premium to be paid by the employer, and where the

wages were below a certain amount, two-thirds of the remainder to come out of the poor-rate. The fund thus raised would provide sick allowance up to two-thirds of the wages, with a provision for the widow and children. It was also intended, he understood, to carry the scheme still further. The failure of Messrs. Briggs' experiment had been referred to, but what was the cause of the failure? The profit, the second year of the experiment, was £30,000, but when the price of coal was considerably raised, and the profits grew to £60,000, they did not like dividing it amongst their workpeople, and that was the cause of the failure. There were many examples of the success of this system in England, and he was sorry he had not the materials with him to quote them.

Mr. H. Solly desired to express his most earnest sympathy with the movement, which was evidently growing, for promoting this participation in profits, and did not think they need be at all discouraged by the failure of one or two attempts in this direction some years ago. One had just been referred to by Mr. Chapman, and they knew how many failures the co-operative movement suffered before it attained its present success. It had almost entirely died out before the Rochdale Pioneers began their wonderfully successful enterprise. There was hardly any social, industrial, or political movement which had not to encounter failure at the outset; and it was only in that way that experience was gained which led to ultimate success. Mr. Chapman, however, was in error as to the cause of the failure of Messrs. Briggs' experiment. He knew Mr. Currer Briggs very well; and he was one of the last employers who would grudge his workmen a share in the profits of the business. If he had been ever so grudging, he would be the last man to be so when he saw beneficial results accruing to the firm from the participation. The real cause of the failure was the relation, or supposed relation, of the firm and the *employées* to the trades union. He would not go into that, but he did not consider the men were to blame at all in the matter. Mr. Briggs himself deeply regretted the cause, and probably if it had rested with him the difficulty would have been got over. The same with Fox, Head, and Co., of Middlesborough. Jeremiah Head threw his whole heart and soul into the matter, and as far as the profits went, it worked well. As regards the beneficial results of this system, he had recently been informed that the manager of the stationery department in one of the largest firms in the metropolis had saved his employers nearly £800 a year through the introduction of the system. This was simply because he felt it to his interest to make every effort to prevent waste. When he mentioned this fact on a former occasion, an employer said that the man must have been shamefully neglecting his duty not to have made this saving previously; but even granted that it were so, you must deal with facts as you find them. If you found a certain system would induce men to be more careful, and increase the profits of their employers, and another would not, it was only common sense to use the one system and not the other. This had been proved to be the case, for where this system was carried out, the saving was immense. One objection often brought against it was, that while the workmen were willing enough to share the profits in a good year, they would not like to share the lesser in a bad year. His answer was this, which might not be correct, but he had always felt it to be sufficient, that the bonus should be calculated, making allowance for the losses of bad years. He did not imagine there would be any difficulty in making a calculation of that character. He entirely endorsed the remarks which had been made, that some change in our industrial system was inevitable. The trade of this country was undoubtedly in a very serious condition; every now and then the reports from consuls abroad stated that in this and that particular trade we were being superseded, sometimes by continental firms, but chiefly by Americans. He was informed by a relative of his, who was in business in New York, that a mining engineer in England told him that his men always preferred American tools. And in illustration of that they found intelligent men, who had worked in America, telling them that there was far more co-operation between employers and workmen there than in this country. He need not go into the causes of that, but the effect was undoubted. The work was carried out in consequence in a way in which it never could be where the employer and workmen were not on friendly terms. Then, again, the question of the patent-laws came in, but that was beside the present subject. He was thoroughly convinced that, although the bonus system acted chiefly upon the pocket, it was also, to a large extent, a moral question as well; and there it appeared to him that the lesson to be drawn from Leclaire's life and character was of incalculable importance. He was thankful to know that his example was being held up, not only by Mr. Taylor and the Chairman, but by a lady friend of his now present, Miss Hart, who had brought it before workmen's clubs. If they could succeed in introducing a more brotherly spirit into the relation of employers and workmen, and get masters and men to have that true sympathy with one another which must lie at the foundation of all success, this bonus system would come in and work well. It never would be broken down, if there were only the same brotherly spirit as prevailed in Leclaire's establishment.

Mr. Nuttall understood Mr. Taylor to suggest that under this system, new profits might be created which were now lost; he did not ask that the workmen should be given anything which the employer now had himself, but that the workmen should be induced to produce new profits, and have a share of it. If that were what he meant, he did not see how any capitalist could object, but he would be glad to induce his workmen to produce more and waste less, and work on more friendly terms with him than hitherto. They would probably live to see this system take root in England, but it had not done so yet, for which, many reasons no doubt could be given. The principal reason he believed was, because the tendency of the age was that more capital per head was likely to be employed in all trades than in previous years. In the cotton trade it now cost the employer £200 per man, and in the engineering and iron trade about the same. Now, it took a working man a good many years to save that capital. When a shoemaker worked for himself in the old days, and could carry his kit with him round the country, it was easy for him to work on his own account, and keep the profits for himself, or to join with others, but it was not so now. There were large workshops in that trade, as in every other, and the amount of capital required per man was much greater than formerly, and this must be the tendency in all trades, because machinery would have to do the work which manual labour had hitherto done; therefore it would be more difficult in the future for the workmen themselves to become the owners of the works in which they were employed; and he felt very strongly indeed that whatever they might desire, the end would be that the public themselves would ultimately supply the capital, employ the workpeople, and share the profits. He did not agree with many of their friends, who thought the workmen would ultimately become the owners of their own works; nor did he even think it desirable that that should be so, because the tendency of the workman was the same as the tendency of the employer; he would make all he possibly could out of the customer. He would sell his shoes or his cloth as dear as he could, and think he was doing right, as the capitalist did now; and not only that, but he would pay the least possible wages. The workman himself, where he was not actually employing himself, but had to employ others, would pay the lowest possible

wages. He had seen this actually done times out of number. He had seen the workmen in Oldham—where 20,000 workmen were shareholders in joint-stock cotton mills—in one mill where they were employed, urge that it was not only right, but that it would pay to give the workmen an interest in their work; and he had seen the same workmen as shareholders holding £5 or £100, invested in the concern, urge that it was not right, and that it would not pay, to give other workmen a share in the profits. These were practical difficulties. No doubt in years to come they would see a considerable improvement, but not in the direction that some of their friends and well-wishers really desired. He had seen it tried with cotton buyers, and fail, because the mere paltry bonus of £1 a week extra to him, when he was in the receipt of £7, £8, or £10 a week wages, had no influence—it was too small. Give him £5 a week extra, and he would neglect his dinner when at Liverpool, and, perhaps, save one-eighth or one-sixteenth of a penny per lb. in buying; and the seller of yarn in Manchester would take the same course. But he had seen other workmen begrudge giving an extra £5 or £10 to men who had acted in this way, though they might have saved hundreds of pounds by it. The middle-class and high-class employers, as a rule, did not do that; and they, as working men, had to learn to be more liberal in such matters. If anything would succeed anywhere, it ought to succeed in Oldham, for there every cotton-mill owner almost had risen from a workman. He knew whether, when he was a workman, he could produce more, and whether he did or did not waste his master's time and material; and every workman knew that he did waste material; every trades unionist knew it, and every employer knew it. The point was how to get them to save it and invest it. In Oldham, there were 25,000 workmen, who owned £4,000,000 of capital, all employed in the cotton, iron, coal, or paper trades; and, surely, they ought to give their own workpeople an interest in their works, which would produce a larger profit divisible among them as shareholders; yet they did not do so, and it could not be said that they were friendly to the principle. The plan had been tried in many concerns—in four or five cotton mills—with the buyer of cotton, the seller of yarn, the engineer, the carder, and others, and they had tried it in the iron trades. In an Oldham engineering works, where he was director for many years, and knew all about it, every workman was actually made into a shareholder to induce him to take an interest in his work and save material, but what was the practical result? Those who were dissatisfied with their wages, combined with others in the workshop or out of it to get more. If they could not get it from the immediate foreman above them, they then tried to remove him. If they could not succeed in that, they tried to get it from the manager, and when they could not get it from him, they tried to remove the manager. When they could not remove him, they tried to remove the board of directors, and the result was they had to be disfranchised. Everybody must regret to see that amongst the workmen themselves, but it was no use hiding these facts. What was wanted, was to get the bulk of the workmen to see that it would be to their interest to save instead of wasting; and that there was more pleasure in working properly than in idling time away during working hours. He could not see how any working man could have any pleasure in idling time away, either his own or his employer's, but they had got into that habit, and he did not really see his way yet to any practical scheme to induce the bulk of the workmen to become more economical of their masters' time, tools and materials. He had tried the principle in a colliery. He and a few friends joined in a colliery and tried to make it succeed. They gave the banksmen an interest in proportion to what they did, and it succeeded with them, but when they went down into the pit and tried to induce the cutters themselves to use less powder, to be more careful about mixing dirt with the coal, and to keep the water away from the mine, and so on, it was impossible to induce the colliers to take any interest whatever in the master's affairs. He offered them an extra sum per ton, but still they could not do it. He thought there was always a fear in the mind of the workmen that there was something else in view when anything was offered them, and the way in which they had been treated necessarily caused them to have those feelings. It would take many years before workmen would feel, as Mr. Jones put it, that they were really trusting somebody deserving of being trusted. He could not tell the meeting one half of what he should like them to understand on this subject, but he thought there were many forms of industrial partnership and co-operation which would succeed side by side with each other. It had succeeded in the works of Messrs. Platt Brothers, of Oldham, the largest engineering works in the world. There there were 20 or 30 men, to whom they paid £1,000 to £1,500 per annum each, with a bonus in addition, but they did not allow the bonus to be withdrawn. It was accumulated with the profits on it, year after year, and when they had been in the firm a certain number of years, they were entitled to sell out. He had many companions. half-a-dozen of whom were in receipt of £500, £600, or £800 per annum, with a bonus, who had been their principal foremen for years, and who did study their employers' interest and their own. But the bulk of the workmen had no interest in the concern; only the heads of departments. It succeeded at Accrington, in the machine works there, and in many other places where heads of departments only were taken into account. He should have been glad if Mr. Taylor had told them where it succeeded what proportion of capital per head was employed, and he should imagine that in the house painters, watchmakers, and many of those industries, the capital was very small indeed, and that there it would succeed better than in large concerns.

Mr. Benjamin Jones said the last speaker had gone into a great number of details to show why the participation of labour in profits should succeed, and then why it should not. Some years ago he was as thorough an advocate of labour having a share of profits as could be found anywhere; probably, he was only an instance of a sort of ebb and flow of opinion which had taken place amongst working men generally. Some years ago, the feeling amongst hundreds and thousands of workmen was that this participation was a good thing; but a great proportion of them, who had been working hardest and thinking most, got rather rich, and then changed their minds, because they got into the position of capitalists. There were concerns where they gave labour a share; but when they found they were getting rich, they thought they could do without the labourers' co-operation, and stopped his profits. Then bad times came, and profits dwindled away, and many believed it was on account of what he considered the unjust treatment of the labourer; and some of those who, in the high tide of prosperity, were against a division of profits, were again changing their minds, and coming to believe that it was the right thing after all. No one had mentioned Mr. Taylor's suggestion to have an association to discuss this question, but the discussion which had already taken place showed how useful it would be; and he thought they could not do better than form such an association, where details could be gone into. It seemed to him an incontestible fact, that to give a man an interest in the profits must have an influence on his industry. Take his own case; he was in service, in a position, where he thoroughly enjoyed the work he had to do, and he would not exchange it on any account.

It might be said that, with such a position, no inducement offered him would make him more zealous, but still he must say that when he had made what he considered a good hit for his employers, it rankled very much in his mind that it did not add a 6d. to his wages. He considered it was essentially unfair that capital should take all profits which resulted from enterprise and integrity of industrious labourers. As the working classes of this country increased in intelligence, they would make up their minds that they would have a greater share in the produce of their industry, and the question for capitalists would be, would they have a grand battle between their *employés* and themselves, or try to devise some such means as Mr. Taylor had suggested, for uniting their interests, and sharing their profits with them. If the question was left to the workmen, they would devise means by which the capitalists should only be allowed 3 or 4 per cent. on his capital. Personally, he should prefer such a solution, but it would take a long while, and he doubted whether it would be applicable to all industries; and, in the meantime, he welcomed the suggestion now made as likely to bring the two great classes into more amity with one another.

Mr. Trewby said the question had been asked, why this principle succeeded in France, and not in England; but he thought the instincts of the two nations were very different. A Frenchman was content to live in part of a house, while an Englishman wanted a house to himself. Then there was a vast difference in emoluments for the same kind of work, as in the case of the clergy, where one man received £1,000 a-year for less work than another received £100 a-year for, and yet they were not willing to set that right. The same kind of thing applied in all industrial occupations. There was a kind of aristocracy in manufacture and distribution. Mind naturally took precedence of the actual labour, and it became the function of the mind to draw around it other minds. No nation had done so much towards increasing the distribution of products as England, and it had been done by simply making the labourer a partner to the employer. In the large distributing firms, down to a certain grade, each man received an emolument according to the profits of the concern. In the large wholesale firms, the buyers were paid according to the amount of the turnover, and under them were salesmen, who were also paid according to their ability. In the case of the large painting and decorating establishment in Paris which had been referred to, he did not suppose there was a large amount of capital employed; but how would the principle work if it were applied to all concerns of the same kind? There was no outlet for a man's ability; if he wanted to start for himself, he had to face the fact that he would lose whatever he had deposited in the concern. In this country a man could work his way up to the top of the tree, and then strike out for himself. The lowest class of labour was always regulated by the demand for increased pay.

Mr. Mineard said he had looked at this question from three different standpoints—as a workman, as a foreman, and as an employer, and he had felt, from the time when he knew how to use his tools, that he ought to have an interest in the work he had in hand. The only interest he could then show was to do his work in the best manner he could, and the result was that he almost always remained with his employers as long as it suited him to stay. When he was a foreman, he made a similar suggestion to that brought forward by Mr. Taylor. He was once carrying out a large job in the country as building foreman, and he suggested to his employer that he should have 10 per cent. on the profits of it, he, on the other hand, offering to deposit 10 per cent. as his share in case of a possible loss. That offer, however, was refused. He was now an employer, being what was called a speculative builder; and, although in good times a builder could make fair profits, in bad times, in the same neighbourhood, and building the same class of property, he might lose twice as much as he had an opportunity of earning in good years. During the last two years he had been, at one time, cornered, and there were then men in his employ who offered to let him have every pound they had. He believed this vexed question of capital and labour could only be solved in the mode suggested by Mr. Taylor; but it seemed only fair that those who shared the profit should also share the loss. He was quite willing to join such an association as had been mentioned, for the purpose of enlightening the workmen themselves, for it could only be done by first convincing them. He had men in his employ whose wages he had often raised, and he never let a holiday go by without giving those in a leading position a bonus. He had seen waste go on in large metropolitan firms to such an extent that he had actually thrown up his work. On the other hand, you might drive men by piecework to do a lot of work which was worth nothing. He only found piecework answer in the simplest operations, such as excavation, and then he never attempted to cut down a man's wages because he earned a good deal.

Mr. George Shipton moved the adjournment of the discussion, which was seconded by **Mr. Botly**.

[The adjourned meeting will be held on Friday, February 25th.]

CORRESPONDENCE.

"SUGGESTIONS FOR PREVENTING LONDON SMOKE."

As it would appear that the statements contained in my letter of the 29th ultimo, have not been rightly understood by Mr. W. D. Scott-Moncrieff, I will endeavour, in as few words as possible, to make the matter clear to him.

In Mr. Moncrieff's scheme, it is proposed to pass all coal intended for fuel through gas retorts, but "instead of taking 10,000 cubic feet of gas per ton from the coal, to take 3,333 cubic feet, and to pass three times the quantity through the retorts, or any other proportion that may be found most convenient." "The result of doing so (he says) is startling;" and, further, he states that the coke or smokeless fuel resulting therefrom would give out 20 per cent. more heat than common coal, and would therefore be found of great service for heating the retorts, while the surplus, viz., that not required in the manufacture of gas, could be used for domestic purposes, thus rendering London a smokeless city.

Now, if the before-mentioned is the scheme which Mr. Moncrieff advocates, then I most emphatically repeat that it has never even been tried—much less adopted—at the Woolwich Arsenal Gas Works.

In Mr. Moncrieff's letter which appeared in the *Journal* of the 11th inst., he remarks that in my letter of the 29th ultimo, I confirm the statements in his paper in every detail and particular. Now, taking his several remarks in the order in which they occur in his letter, we shall see how far his statements are borne out by facts.

Mr. Moncrieff alleges that when in difficulties the manager of the gas works at Woolwich Arsenal, had used a "short extraction." This is entirely incorrect; in every case he allows the coal—whether common gas coal or cannel—to remain in the retorts just as long as is necessary for extracting all the gas from it (and not one-third only, as recommended in Mr. Moncrieff's scheme), and the length of time necessary for this operation depends entirely upon the character of the coal—

for common gas coal, about six hours, and for cannel, about four hours.

Mr. Moncrieff then alleges that the fuel resulting from the short extraction is superior, and that I confirm this by stating, "that the coal used was volatile cannel, and that on a *long extraction* it contained very little heating properties, and was not used under the retorts." Now, my letter of the 29th ultimo contains no such statement, but the very opposite, for I most distinctly pointed out that it was the coke from the ovens, worked during a four-hour (or short time) charge, and with a volataile cannel coal, which contained very little heating properties, and consequently was not used as fuel under the retorts. The words in italics are Mr. Moncrieff's, not mine, and they do not occur anywhere in my previous letter.

Mr. Moncrieff then asks, do I mean to say that the fuel was worse under a short extraction than under a long one. Not having tried his scheme of "short extraction." I am unable to answer this question. What I state is, that the coke resulting from the six-hour charges, for which we always employ common gas coal, usually "Pelaw," is of good quality, and possesses fair heating properties, and makes a very good fuel; whereas, that resulting from the four-hour charges, for which we invariably use a cannel coal, is simply worthless as a fuel.

Mr. Moncrieff then asks, do I mean to deny that the best gas comes off during the first two or three hours, and do I deny that it comes off most rapidly during that period? I am not aware that I have made or denied any statement in regard to either of the above questions, and, as I am only concerned at present with the statements made by Mr. Moncrieff in regard to the Royal Arsenal Gas Works, I do not think it necessary to widen the subject under discussion. At the same time, in reply to his last question, I do most distinctly deny ever having adopted the scheme which he advocates in his paper, even to meet a few exceptional emergencies. My endeavour has always been to get, profitably, as much gas as possible out of the coal, and to leave little or none in the coke, whereas, in Mr. Moncrieff's scheme, he advocates taking only a little out of the coal (about 3,000 cubic feet per ton) and leaving a very large portion—between six and seven thousand cubic feet—in the coke.

Now, although I shall be pleased to adopt any plan that has been practically tried and proved, and which will enable me to manufacture a better and cheaper gas, I hope for the present, and until Mr. Moncrieff has something better and more reliable to put before us, to retain "sufficient intelligence" to deter me from attempting to convert good profitable gas works into establishments for partly carbonising coal and manufacturing a gaseous coke or smokeless fuel, of such doubtful value, that in the condition in which it would come from the retorts, the mere handling and exposure to the weather for a short time would, I believe, convert it into a heap of "breeze" or rubbish.

Mr. Moncrieff states, in conclusion, that he was unaware of any official relations between Mr. Wallace and myself, and, further, that he is not, even now, aware what those relations are. I can scarcely imagine this to be possible after his reading my letter of the 29th ultimo, and its postscript, and seeing that there are so many ways of obtaining the information had he wished for it, inasmuch that I have been connected with the public service for the past 30 years. I can only attribute Mr. Moncrieff's stated continued ignorance to the fact that he has taken as little trouble to inform himself on this point, as he did to investigate and ascertain the true state of matters before making the incorrect and random statements which appear in his paper.

Royal Arsenal, Woolwich, Feb. 14. J. A. C. HAY.

As my name has been most freely used by Mr. Moncrieff in the paper he recently read before the Society of Arts, I beg to say that the statements made by him referring to the Royal Arsenal Gas Works are wholly incorrect, and were not given to him by me. Neither do I know anything of Mr. Moncrieff, further than that the first time I ever saw him was less than a month ago, when I met him looking over the works here as an ordinary visitor. JOHN WALLACE.

Royal Arsenal Gas Works, Woolwich.

[In order to prevent further correspondence, the letters from Mr. Hay and Mr. Wallace were sent, in proof, to Mr. Scott-Moncrieff, with a request that he would reply to them, if he wished to do so. His answer is given below. A few sentences have been omitted, which refer, principally, to personal matters, rather than to matters of fact. This correspondence will now be closed.—ED. *S. of A. J.*]

I have the proofs you have sent me of letters from Mr. Hay and Mr. Wallace. The former gentleman, I find, is not known among gas-managers as an expert; it is to be presumed, therefore, and he seems to admit, that he obtained the information which forms the basis of his letters from Mr. Wallace. Your readers may judge of the disadvantage I am at in this correspondence, when I inform them that so far from Mr. Wallace having "seen me for the first time less than a month ago," and "having met me looking over the works as an ordinary visitor," he was specially introduced to me last autumn by an engineer of the highest eminence, belonging to the Gun Factory, and a personal friend of my own. On that occasion, Mr. Wallace took me to what he called his "thinking-box," and we went into the figures of my proposed scheme, which he did with expressions of the greatest interest. It was then, and on other occasions since, that he told me of his experience with regard to short extractions. It is to this information, and this alone, I referred. To make a general practice of a short extraction at Woolwich Arsenal, where the fuel used for heating is out of all proportion to the quantity used for light, is what no man in his senses would think of. This, however, has no connection with what Mr. Wallace did or did not tell me about the short extractions. In Mr. Hay's last letter, he suggests that nothing but the every day practice of gas-making had been resorted to at the Arsenal. In his previous letter he speaks of exceptional practices. I cannot reconcile these discrepancies, nor do I care to make the attempt.

W. D. SCOTT-MONCRIEFF.

Feb. 17.

MEETINGS OF THE SOCIETY.

ADJOURNED MEETING.

Friday evening, at eight o'clock:—

FEBRUARY 25.—Discussion on Mr. Sedley Taylor's paper on "The Participation of Labour in the Profits of Enterprise." W. H. HALL will preside.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

FEBRUARY 23.—"River Conservancy." By CHARLES NEVE CRESSWELL. The Hon. CHARLES WENTWORTH FITZWILLIAM, M.P., F.R.G.S., will preside.

MARCH 2.—"Lighthouse Characteristics." By Sir WILLIAM THOMSON, LL.D., F.R.S. F. J. BRAMWELL, F.R.S., Chairman of Council, will preside.

MARCH 9.—"Ascents of Chimborazo and Cotopaxi, in 1880." By EDWARD WHYMPER.

MARCH 16.—"Buying and Selling; its Nature and its Tools." By Prof. BONAMY PRICE, M.A. Lord ALFRED S. CHURCHILL will preside.

MARCH 23.—"The Increasing Number of Deaths from Explosions, with an Examination of the Causes." By CORNELIUS WALFORD.

March 30.—"Recent Advances in Electric Lighting." By W. H. Preece.

April 6.—"The Manufacture of Glass for Decorative Purposes." By H. J. Powell (Whitefriars Glass Works).

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

March 1.—"The Languages of South Africa." By Robert N. Cust.

March 15.—"Diamond Fields of South Africa." By R. W. Murray.

April 5.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

February 24.—"Deep Sea Investigation, and the Apparatus used in it." By J. Y. Buchanan, F.R.S.E., F.C.S. Captain Sir George S. Nares, R.N., K.C.B., F.R.S., will preside.

March 24.—"The Future Development of Electrical Appliances." By Prof. John Perry.

The meeting previously announced for April 7 will be held on May 12.

Indian Section.

Friday evenings, at eight o'clock:—

March 4.—"The Results of British Rule in India." By J. M. Maclean.

March 25.—"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Second Course will be on "Watchmaking," by Edward Rigg, M.A. Three Lectures.

Syllabus of the Course.

Lecture III.—February 21.

Necessity of efforts to promote the art in this country—Need of education, theoretical and practical, in horology—Literature—Great want of uniformity in gauges, screws, &c.—Exhibition of ordinary and complicated watches, and of watchmakers' tools—Conclusion.

The Lectures will be illustrated by Specimens, Models, and Diagrams. The different movements, &c., will be shown enlarged on the screen by means of the Aphengiscope and the Electric Light.

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

March 7, 14, 21, 28.

The Fourth Course will be on "The Art of Lacemaking," by Alan S. Cole. Three Lectures.

April 25; May 2, 9.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

May 16, 23, 30.

Admission to Meetings.

Members have the right of attending all the Society's meetings and lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 21st...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Edward Rigg, "Watchmaking." (Lecture III.)
Royal Asiatic, 22, Albemarle-street, W., 4 p.m. 1. Rev. John Cain, "On the Kois or Ghouds of Central India." 2. Mr. Cyril Graham, "Remarks on the Avar or Lasghian Language of the Caucasus."
Royal United Service Institution, Whitehall-yard, 8½ p.m. Mr. W. H. White, "Pumping Arrangements of Modern War Ships."
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. G. R. Crickmay, "Ecclesiastical Dilapidations."
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. 1. Dr. J. P. Thompson, "Implements of the Stone Age as a Primitive Demarcation between Man and other Animals." 2. Mr. J. E. Howard, "Scientific Facts and the Caves of South Devon."
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. J. E. Hodgson, "Art Among the Ancient Greeks."

Tuesday, Feb. 22nd...Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. A. Schäfer, "The Blood." (Lecture VI.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Max Am Ende, "The Weight and the Limiting Dimensions of Girder Bridges."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. The Right Hon. Sir Bartle E. Frere, Bart., "The Union of the Various Portions of British South Africa."

Wednesday, Feb. 23rd...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. Charles Neve Cresswell, "Rivers Conservancy."
Geological, Burlington-house, W., 8 p.m. 1. Mr. T. V. Holmes, "The Permian, Triassic, and Liassic Rocks of the Carlisle Basin." 2. Prof. W. J. Sollas, "*Astroconia Granti*, a new Lyssakine Hexactinellid from the Silurian Formation of Canada."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. W. A. Barrett, "The Fathers of the English Church Music."

Thursday, Feb. 24th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Chemical Section.) Mr. J. Y. Buchanan, "Deep Sea Investigation, and the Apparatus used in it."
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Capt. W. De W. Abney, "One Aspect of Colour."
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. J. W. Bradley, "Book Decoration."
Royal Institution, Albemarle-street, 3 p.m. Prof. Pauer, "History of Drawing-room Music." (Lecture II.) With Musical Illustrations.
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Friday, Feb. 25th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Adjourned Discussion on Mr. Sedley Taylor's paper, "The Participation of Labour in the Profits of Enterprise."
Royal United Service Institution, Whitehall-yard, 9 p.m. Captain S. Long, "A Study of the Tactics of Naval Blockade, as affected by Modern Weapons."
Royal Institution, Albemarle-street, W., 9 p.m. Dr. J. S. Burdon-Sanderson, "Excitability in Plants and Animals."
Quekett Microscopical Club, University College, W.C., 8 p.m.

Saturday, Feb. 26th...Ladies' Sanitary Association (at the House of the Society of Arts), 5½ p.m. Dr. B. W. Richardson, "Domestic Sanitation or Health at Home." (Lecture III.)
Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. C. V. Boys, "An Integrating Machine." 2. Mr. Shelford Bidwell, "The Telegraphic Tranmission of Pictures of Natural Objects."
Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Stuart Poole, "Ancient Egypt in its Comparative Relations." (Lecture II.)

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FRIDAY, FEBRUARY 25, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

MR. WHYMPER'S PAPER ON CHIMBORAZO.

At the ordinary meeting, on Wednesday, 9th March, Mr. Edward Whymper will give an account of his recent ascents of Chimborazo and Cotopaxi. As it is expected that many members will wish to hear Mr. Whymper, it is proposed to make special arrangements for this meeting, the usual rules for admission being suspended for the evening. Admission will be by special tickets only, and these will be issued to members in the order of application. Should a sufficient number of applications be received by Monday, the 28th February, to justify such a course, arrangements will be made for holding the meeting in a larger room than the Society's own room, otherwise it will be held there as usual. The names of members applying will be registered, and tickets will be issued by the 4th or 5th March. Either one or two tickets will be sent to each applicant, as the accommodation may permit.

Members are particularly requested to take notice that if they wish to attend they must provide themselves with a ticket, as no person, member or other, can be admitted without a ticket.

H. TRUEMAN WOOD, *Secretary.*

CANTOR LECTURES.

The third and concluding lecture of the second course was delivered on Monday, 21st inst., by Edward Rigg, M.A., on "Watchmaking." The Lecturer urged the necessity of efforts to promote the art in this country; and pointed out the need of education, theoretical and practical, in horology. The action of repeating and other watches, was shown on the screen by means of the aphengiscope and the electric light.

Mr. GLASGOW proposed a vote of thanks to the lecturer, and expressed, in the name of the watch-making trade, the great pleasure that those who attended the course had received in listening to the lectures. It was now easy to obtain popularity by running down the English trade, and he was glad that Mr. Rigg had not sought such popularity, but had been able to speak a good word for the English manufacturer, who produced the best watch in the world.

The CHAIRMAN (Mr. B. Francis Cobb, Treasurer of the Society), in putting the vote of thanks to the meeting, drew attention to the trade statistics, as furnished by the lecturer, and spoke of them as neither creditable to the trade nor to the country. He alluded to the evil effects of trying to keep any trade as a close trade in the present time, and showed how the great business of supplying clocks and watches to the Colonies had gone past this country. He spoke hopefully, however, of the result of the technical horological education, now working under the auspices of the City Guilds, and he exhorted his hearers not to underrate their opponents, but to take and adopt new ideas from whatever source they could obtain them.

The lectures will be published in the *Journal* during the summer vacation.

HOUSE SANITATION.

The Council offer the following Medals for the best Sanitary Arrangements in Houses built in the Metropolis, the plans of such arrangements to be exhibited in the Society's Rooms, Adelphi, in June, 1881, and to be sent in on or before 12th May, 1881:—

1. One Silver Medal for the best sanitary arrangements, carried out and in satisfactory working, in a house let out in tenements to artisans, for which a weekly rental is paid.

2. One Silver Medal for the best sanitary arrangements, in actual working, in a house of the yearly rental of £40, or less, to about £200 in value.

3. One Silver Medal for the best sanitary arrangements, in actual satisfactory working, in a house of the yearly rental value of £200 and upwards, to any amount.

4. The houses must be open to the inspection of the Judges, who, in considering their award, will be guided by the suggestions of plans for main sewerage, drainage, and water supply, made under the Public Health Act, 1875. The houses must have been in actual occupation within the last three months, and a Certificate must be given by the occupiers, on a printed form, stating the satisfactory working of all the sanitary arrangements, such form to be obtained at the Society of Arts.

5. The houses may be old, fitted with modern sanitary arrangements, or may be new. They must be within the metropolitan area of the Board of Works.

6. The sanitary arrangements must include the conditions for good water supply, drainage, warming, and ventilation of the house, and precautions taken against frost.

7. The medals may be awarded to the occupiers of the houses, or the lessees, or the owners.

8. The plans must consist of a ground plan and sections, to the scale of not less than one inch to five feet; details of not less than one inch to the foot. The plans may be accompanied by specifications.

9. The names of the architects, surveyors, or sanitary engineers who directed the sanitary arrangements should be given, and Certificates will be awarded to those whose plans obtain the Medals.

PROCEEDINGS OF THE SOCIETY.

TWELFTH ORDINARY MEETING.

Wednesday, February 23rd, 1881; the Hon. Chas. Wentworth Fitzwilliam, M.P., F.R.G.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Brevetor, Thomas, Kimberley-house, 2, Evering-road, Stoke Newington, N.
Harris, Edward, London, Upper Canada.
Smith Henry, J.P., Ellingham-hall, Bungay.
Underdown, Robert George, A.I.C.E., Manchester, Sheffield, and Lincolnshire Railway Company, Manchester.
Uren, John C., Cornwall-terrace, Penzance.

The following candidates were balloted for, and duly elected members of the Society:—

Bolas, Thomas, 2, The Terrace, Turnham-green.
Chambers, William E., Eversfield, Sutton, Surrey.
Courteen, Henry, 336, Clapham-road, S.W.
Felkin, Robert William, F.R.G.S., Pennfields, Wolverhampton.
Kirkham, Thomas Nesham, 21, Abingdon-street, Westminster, S.W.
Lee, Edwin, 43, Devonshire-street, Keighley.
Le Rossignol, Francis, 1, Gresham-buildings, Basinghall-street, E.C.
Magniac, Arthur, 36, Hertford-street, Mayfair, W.
Martindale, William, 10, New Cavendish-street, W.
Murray, R. W., 179, Upper Thames-street, E.C.
O'Donnell, William Arthur Maxwell, 4, Gladstone-street, London-road, S.E.
Parr, Samuel, 7, Finsbury-square, E.C.
Pheasant, William Craster, 8, Edwardes-square, Kensington, W.
Raffety, John Henry, 4, The Terrace, Richmond-hill, Surrey.
Swanzy, Francis, 147, Cannon-street, E.C.

The paper read was—

RIVER CONSERVANCY.

By Charles Neve Cresswell.

Continuous floods, abnormal diseases, and widespread devastation, crowned by a succession of bad harvests, have brought about a crisis in sanitary history, and a cry has gone forth, like that of David of old, to be "delivered out of the mire, and out of the deep waters." That cry has reached the precints of Westminster, and the wheel of legislative progress begins to revolve once more. In 1879, the Duke of Richmond and Gordon had already brought in a Bill for the conservancy of rivers, which passed through the House of Lords, but was lost in a flood of political excitement. In the previous year, at the instance of the Prince of Wales, this Society, as is its wont, led the way by a public conference; and, subsequently, offered prizes for the best suggestions, with the object of dividing England into watershed districts, and organising provision for a supply of pure water as the first necessity for the health and comfort of the people. The Society's *Journal* was filled with contributions on the part of eminent authorities, geologists, and engineers, in response to this invitation, whilst the Duke of Richmond's Bill above mentioned was the practical and immediate result. In 1880, nature herself came to the aid of the philosophers, and carried the question out of the range of theory and polemics, by a series of almost unprecedented floods, which followed one upon the other throughout the kingdom. The matter assumed the proportions of a national calamity, and the Duke of Bedford led a deputation to the Minister, composed of all sorts and conditions of men, who had merged political distinctions in the sympathy begotten by common misfortune. This brief historical retrospect is interesting as a political lesson, teaching us that the conclusions of science, the experience of our neighbours, and the silent testimony of each occupier's individual sufferings, will not avail to move the public, or rouse the Legislature into action. Certain disquieted spirits discerned the "writing on the wall," but their warnings were received with indifference, and the public waited, as it always waits, for a portent; for some revelation in the guise of plague and pestilence; and they have had it in submerged pastures, infected cattle, deserted homesteads, vacant farms, landlords in search of tenants in lieu of competition for farms, broken dykes, and broken hearts, and dismal forebodings everywhere.

I propose to consider the subject of river conservancy under three distinct heads. First, the conservation of rivers for the purposes of navigation; secondly, for the purposes of utilisation and fertilisation; and thirdly, conservation in the sense of purification, including, of course, the preservation and breeding of fish.

The subject is far too wide for the limits of a single paper, and I have condensed my original draft by cutting it in half. I have only to hope that I have reserved for my audience this evening the better half of my reflections.

Two measures are now before Parliament, having for their object the establishment of Conservancy Boards to effect each of these three objects, by methods differing in respect of details, but both alike armed with powers to rate the districts to be

benefited by their operations. The Government measure in the House of Lords is certainly more comprehensive than that to be introduced into the House of Commons, but there are conspicuous defects common to both. The Rivers Thames and Lea, with others, are excluded from both measures; both err upon the old lines of creating new authorities, with arbitrary districts to be defined by the Local Government Board, involving the inevitable local inquiry, with its train of circumlocution, law costs, and correspondence. Before entrusting the central department with the discharge of duties so novel and extensive, and before the limits of any area of jurisdiction can be defined, the Ordnance Survey Department of the United Kingdom must complete its work. The attention of the public has been lately called to the startling fact that in many districts that survey is still incomplete. This is a task worthy of the Imperial Government, for which the Department is in every respect qualified; moreover, the cost should be borne by the State, and not be cast upon the ratepayers in the several localities. It is alleged that the Upper Thames Valley Commissioners expended nearly £5,000 out of their own resources in this preliminary survey, that should long ago have been completed as part of a national work.

The functions of Imperial administration end where those of local self-government begin, and if the Department intervene at all in the definition of areas, it would find abundant occupation in completing that survey, which is described, on high authority, as in a more backward condition than that of any nation in Europe.

With regard to the local jurisdictions to be created by these Bills, Mr. Magniac's measure errs on the side of excess, while the Government measure errs rather in the opposite direction. In the one case we have a redundance of authorities which may clash, and, in the other, combinations of several basins, too wide for efficient control. The Government Bill might include the basins of the Trent, of the Ouse, and of the Aire and Calder, within the definition of the basin of the Humber. The basins of the Avons would be within that of the Severn; and if these are included under one general Conservancy Board, we shall combine areas which have neither geographical affinity, community of interest, nor capacity of cohesion. There is no definition in the Bill of the basin of a river, and it is manifest that such rivers as the Wye, the Trent, and the Calder, require the supervision of a separate conservancy. Mr. Magniac's Bill, on the other hand, proposes, as the unit of area, a triplet of parishes, or a single municipal borough. A combination of these units constitutes a district, and a General Board will have almost despotic authority over the basins of rivers which have their outlets in the sea. The extent and limits of such districts and sub-districts is left to the sagacity of the Government Inspector to determine. They ought, in my humble opinion, to be defined by the Act itself, otherwise we shall be overlaid by a multitude of petty jurisdictions in counties, such as those of Lincoln and Nottingham. The first of these contains 750 separate parishes, besides sundry Town Councils, the latter 300 parishes, comprising nine Poor-law Unions. And we are confronted by the possible creation of 250 separate sub-districts in the county of Lincoln, each having its own limits and independence of action; each moved by its own jealousies and prejudices to thwart and hamper those who are situate below, above, or around them. The General Board, it is true, has the power to restrain mis-directed energies, as well as to enforce the performance of duties required by the Act. How this Board of Control will avail to overcome local obstruction—the inertia and stolidity of the provincial mind—is yet an unknown quality. It is, in any event, a leap in the dark, and a novel experiment in local self-government.

The simplicity of the Government Bill is in accord with the tendency of modern legislation, which aims at concentration rather than the diffusion of local authority. There is, indeed, a maze of jurisdictions to be found on the face of every county, overlapping and jostling each other in most admired disorder. If the Legislature could find time and occasion to determine once for all the unit of local administration, it would cut the Gordian knot of sanitary legislation. Every constituted authority would thus consist of groups or combinations of the units; and we should no longer be bewildered by a redundance of authority—postal, sanitary, magisterial, and parochial, "the rotten relics of antiquity," as a profane critic once styled them, without sympathy, or the hope of intelligent co-operation. It was anticipated that a Liberal Parliament would effect this grandest of all reforms, by the creation of County Boards—local parliaments—within the limits of each county, charged with all the administrative functions of local government, elective and representative, and enlisting the services of that wealth and intelligence which now too often keep aloof from the turmoil of parochial politics. Such a creation as this would re-animate the whole system of local administration. Above all, would these bodies be competent to undertake the conservation of our rivers, having their jurisdiction defined by historic land-marks, well-known and understood by the people. The constitution of these local parliaments has been again and again urged in this hall, and I venture to think that the experiment about to be made in Ireland might be advantageously extended to the counties of England, in lieu of a network of complex jurisdictions, to be developed under the cold shade of an Imperial department, and involving the worst evils of centralisation, which must, sooner or later, break the back of local independence, by saddling upon it that modern "Old Man of the Mountain," the Local Government Inspector.

The Government Bill divides the land to be rated for conservancy purposes into lowlands, midlands, and uplands, contributing in the proportion of one-sixth as a maximum measure of the relative benefits. In Mr. Magniac's Bill there are but two classes, even more widely contrasted. This will tax the energies of the Government Inspector, and throw each district into social fermentation by contests, local and Parliamentary. We are floundering again in the quagmire of local inquiries.

Assuredly it is not the province of the central bureau in Whitehall to indicate the limits of a river flood, or to determine how far this or that land is vitally interested in the maintenance of the arterial drain of every watershed. Desolate

homesteads, and depreciated properties, mark too well the limits and extent of these liabilities. Let the Government pass a Conservancy Clauses Consolidation Act, embodying the general principles and regulations by which all Conservancy Boards will be governed in the future, such as was enacted for the construction of railways, and of waterworks, and for the manifold purposes of public health, and leave the details of local administration to those who are best able, by local knowledge and experience, to determine them. If County Boards were established, they would be the best tribunals to determine these questions of relative rateability between upland and lowland throughout the watershed; and where a river constitutes the frontier line, or division between two or more counties, the conservancy would be composed of committees of the Board of each county, and thereby we should realise the conception of Mr. Stansfeld, when he recommended "simplification of areas and authorities," constituted for all purposes and functions for which those areas are fit.

Navigation.

For improving and maintaining the navigation; for maintaining dykes already existing, or constructing new ones; for removing obstructions, lowering dams and weirs; in a word, for all the purposes of repair, of maintenance, and of improvement, these Acts confer ample powers, which are indispensable to every conservancy. It may, however, be asked whether rivers beyond certain limits of tidal waters are now required for navigation at all, seeing the marvellous extension of our railway system in every valley and nook of this kingdom. It is certain that many rivers, once the silent highways of inland commerce, are now well nigh deserted, and if the interests of navigation are of paramount importance in these days, it will be necessary, not only to lead the waters into our rivers, but to keep them there for times of need, when drought shall follow present abundance. It is easy, by a judicious expenditure of money and brain power, so to control the stream, that your river shall be full in ordinary seasons; but to replenish and maintain that stream when the cycle of dry seasons recurs, as it assuredly will, is a much more complex problem. The floods of the past few years should not blind us to the probable recurrence of a season when we shall have too little water rather than too much, whether that deficiency be due to the wholesale abstraction of water for the supply of dense populations, or to the reckless misuse of bountiful rain, as the cheaper vehicle which modern civilisation calls in aid to convey the sewage of those populations to distant outfalls. In selecting such outfalls for the disposal of sewage, engineers are apt to think less of the requirements of the riparian owners than of those of the towns which invoke their aid to rid them of a nuisance. In such cases, it often happens that the waters which should replenish the rivers are diverted from its natural channel to another area, where they may be regarded as a curse rather than a blessing. The late Mr. Cubitt, twice Lord Mayor of London, when contemplating the gigantic scheme of sewage interception projected for this metropolis, used to say that the removal of the waterworks to points above Teddington Lock, and the wilful waste of water as a vehicle of sewage within the metropolis, would, sooner or later, impair the volume and scour of the Thames through 30 miles of its course; and that some of us indeed might live to see the results of such improvidence. It is rash to prophesy in these days, but when that millenium, which we are all fondly anticipating, shall arrive, when "*Sanitas sanitatum, omnia sanitas*" will become not a bye-word but a reality, we shall keep our sewage out of our rivers as the first condition of their purity, and permit the rainfall to pass through its natural courses unpolluted, and fitted for the needs of industry and commerce along their course. If our drains and sewers were properly constructed of sufficient, and no more than sufficient, capacity, town sewage would supply its own vehicle, thus avoiding the danger of huge elongated cesspools, which convert the bournes and brooks of our cities into rivers of pestilence.

Irrigation, Drainage, and Protection of Lands from Injury by Floods.

For these and analogous purposes, both measures provide abundant powers, in addition to the power of rating the inhabitants of each area, in order to supply the necessary funds for the requirements of the conservators. There would be no dispute as to the necessity and efficacy of such provisions. It is only when we come to the question of degrees of liability that we can see in the mind's eye a cause of future contention and conflict; but the question whether uplands should be rated at all remains, and is by no means so easy of solution as has been sometimes contended. Doubtless the low lands benefit most by new works, as they have suffered most by the neglect of old; they have in any event to bear the burden of excessive rainfall upon the uplands, and this contingency affects their price and value; on the other hand, those above the range of floods are benefited by the outfall for natural drainage, and it is known that highlands attract the rain-clouds, and that more rain falls upon the hills than upon an equal area in the valleys beneath. This alone would be an argument for not exempting them altogether, and the conservancy-rate, if spread over a sufficiently extensive area cannot be a grievous burden to any part of it. Though we accept the principle of a common liability within certain limits, for the common good of all, I believe that this vexed question will never be adjusted in the turmoil of local inquiries, but must be resolutely grappled with and determined in the serener atmosphere of Parliament. Already there are rumblings of discontent from the fen-country of Cambridgeshire, where costly works, involving an annual charge, have long ago been executed. It would be unjust to throw upon those who have had the courage to help themselves an additional burden for the benefit of others who have been supine or penurious; and the demand has been made for a further sub-division—to be termed "protected lands," which have completed local works for their own protection; and are entitled thereby to be placed on an equality with the most favoured districts.

The prevention of those continuous floods, of which the effects are too patent to every traveller, is, after all, the most important of the duties which will devolve upon these Conservancy Boards. We have been warned, by an eminent authority, that the

elements "upon which floods depend are entirely beyond the reach of human interference." The speaker, of course, referred to excessive floods, and we at once admit, without reservation, that neither the salt ocean, nor the sun's heat, which constantly evaporates it, will be within the control of any conservancy. There is a "reign of law" in nature beyond the reach of Acts of Parliament, and to that law we must perforce submit. This self-same salt ocean, and the sun's influence upon it, have worked together for good, and for the same almighty purpose, from primeval times. The question for consideration in these latter days is—What are the causes which have made inundations—once rare, and only to be collected from the memory of the oldest inhabitant—the normal condition of the Midland counties? On the one hand, it is said that it is due to the perfected system of land drainage, in the interest of agriculture, which carries down the rainfall from upland and midland with much greater speed and certainty than formerly, whilst the capacity of the river bed, which once was ample to contain the flood, is silted up from day to day by mud, and *debris* from the upper reaches. On the other hand, it is asserted that deep drainage increases the absorptive power of the surface soils, and that the rainfall now soaks deeper into the pores and crevices of the earth, where formerly it ran from saturated surfaces direct into the river, when once the shallow sponge was filled, and downward filtration precluded. Whatever force may be due to either argument, this will not account for the phenomena constantly recurring of floods, where no floods were within the memory of man; and to determine the question, finally, would require not only patient investigation, but also data and statistics which are not yet forthcoming, for the use of scientific demonstrations. Conclusions vary as to the character of soil and strata; and each observer holds by the result of his own personal observations. Whenever it rains for twenty-four hours, men look to the too familiar column of the daily journal, and read a calamitous tale of floods in the Midlands, as we were wont to look with grim misgivings for a list of "wrecks and casualties" after an equinoctial gale. It may be that in these days of newspaper enterprise, of special correspondents in every town, endowed alike with strong imaginations and irrepressible energy, nothing is lost in the relation of it to the eager reader, who scans, with his daily bread, a catalogue of "moving accidents by flood and field." Every shepherd tells his tale of woe to the interviewer, and there is now-a-days a craving for sensational news which neither existed nor was dreamed of in the philosophy of our forefathers. It may be the march of civilisation, but there is no hiding "of a light under a bushel;" our virtues and our vices, social evils and misfortunes, the incidents of every trade and every occupation, are proclaimed upon the house-top without reserve or extenuation. It was far otherwise a century ago. The floods of Yorkshire had abated before their existence was known in London, and dry land had reappeared in the valleys of Somerset before the good citizens of Carlisle had ever heard of the deluge. In this year of grace, the telegraph repeats each harrowing detail with painful iteration. We are, however, not alone in our struggles to control by human skill the forces of nature; this has been done successfully in Holland, where the people live deep down in the hold of a ship, as it were, ever on the watch for the slightest sign of crack or leak; in Italy, also, upon the plain of Lombardy, the yellow floods of the fruitful Po are curbed, controlled, and utilised for the beneficent purposes of man; and with all our self-glorification as an eminently practical people, it is to these two nations after all that we shall have to look for practical lessons in the art of river conservation. Time fails me to describe how the sturdy Hollander won his birthright from the sea, how he kept it through centuries of toil and persecution; how the floods of Rhineland have become a river of wealth and fertility, and the Rhine delta converted into a luxuriant garden; but they who run may read, and those who aspire to local fame and usefulness, and to serve the State upon these new Conservancy Boards, will find the system of scientific drainage, as developed in the Drainage Unions of Holland, the best model for their imitation. Mr. J. Clarke Hawkshaw has described it in a luminous paper, which will be found in the *Journal* of this Society, vol. xxvii., p. 848. The Government may well take a lesson from that cradle of self-government and independence, by establishing a central department of water engineers similar to the College of the "Water-Staat" in the Hague, of which Mr. Dirks is the head. This department deals with all matters relating to the flow of rivers, and the levels of floods, and controls the drainage of the polders and fens of Holland from a common centre, as Count Moltke directed the operations of a grand army from the table of his bureau; an example in every way worthy of our imitation, which would ensure a succession of trained and experienced men, directed to this particular branch of engineering science.

Practical men have long been of opinion that something like this system of central control should be adopted along the course of our rivers—that every weir and lock should be connected by telegraph, governed from some point of vantage to insure concerted action—so that whenever the approach of a flood be announced, a comparatively empty river would be ready to receive it.

There are yet other causes of flood and inundation, which have not escaped the observation of men like Mr. Parker, of Oxford. One, and not the least important, is the reclamation of the numerous meres, like Oxham Mere, on the Thames, or Whittlesea Mere, in the valley of the Ouse, and the embankment and cultivation of large tracts upon each river bank, which formerly, in times of flood, were always covered; and at other times and seasons were utilised as commons of pasture, for the use of all. Another cause is the silting up of the river channels by the *debris* and detritus which the neglect of past years has allowed to accumulate. To the first I attribute the greatest importance. These meres and marshes once marked the course of every stream as it approached the sea, and became reservoirs for superfluous waters, and safety-valves to the surrounding districts, serving the same purpose as the bosom lands of Holland, which are maintained with the most vigilant supervision for the storage of flood waters in the lowlands around them. Such were

the saltings of Essex, at times covered by the waters of the Crouch and Blackwater, affording, in dry seasons, a precarious pasturage to the neighbouring communities. Where these wide reaches, or ancient morasses, have been reclaimed, embanked, and won from the sea, we find too often the walls and dykes neglected and out of repair, and the storm of the 18th of January has awakened us from a sleep of half a century, and made the inhabitants of some districts acquainted with misfortune who dreamed that they had kept themselves safe from inroads of the sea. Time forbids me to enlarge upon this topic, but the subject is in good hands, and only too ripe for the attention of the Legislature.

In the valleys of the Tame and Trent, large tracts of farm and meadow land have become an inland sea. These rivers, choked with mineral and manufacturing filth, leave behind, when they do retire, a film of poisonous filth to kill the herbage, and infest the soil with sedge and "tussock" grasses, which convert the finest pastures into an unprofitable morass.

Something is being done, we are told, by the Thames Drainage Commissioners, under their special Act, to maintain that river as nature intended it to be—the main drain of the upper valleys; and this brings us to the inquiry so often made in this hall—Why is it that in all these measures of sanitary preservation the metropolis and the Thames are exempted by special saving clauses? In Mr. Magniac's Bill, the Thames, the Lea, the Mersey, the Medway, the Tyne, the Wear, and the Tees, representing well nigh half the watershed area of England, are excluded. The Government Bill is less curtailed in its operations, but both measures are careful not to disturb the rights of the Crown, or the ancient privileges of the Lord High Admiral of the Kingdom. It is, however, to the Thames I would particularly direct attention. There is a mysterious sanctity about this river and the precincts of the metropolis. It is a kind of "Alsatia," like the old sanctuary of Whitefriars, with its benefit of clergy outside the pale of the constitution, and beyond the reach of the common law. In 1848, the metropolis and the Thames were specially excepted in the preamble of the first Public Health Act, and the duties of drainage were confided to the charge of certain Commissioners who have "damned themselves to everlasting fame" by directing the sewage of London and its suburbs to be passed into the River Thames as the best available means of disposing of a nuisance. Twenty years later, the Conservancy Acts were passed to compel the unfortunate victims of misdirected zeal to take it out again, and retrieve, if possible, the ancient purity of the stream. From the Pollution Act of 1876, the Thames and the metropolis were again excepted; and in these two measures now before us, the Thames is exempted, although it is admitted, on all hands, that the Conservators of that river have every power for good or evil, except that which this Act would give them, namely, the means of rating the owners and occupiers who are to be benefited by their operations. The tolls of navigation, and the subsidies of the water companies, do not suffice for all the purposes of the Thames Conservators, and they would gladly have the powers which these Bills would confer upon them of providing increased funds for necessary improvements. As it is, the want of means to do good deeds is the ever ready excuse for leaving them undone. It certainly cannot be argued that the provisions for the prevention of floods are not required for metropolitan waters. Bermondsey and Windsor, Lambeth and Hampton, would tell a far different tale, and the irony of the situation is complete when we see the Royal domain of Windsor faring no better than the squalid dens of Rotherhithe; whilst we read in the last official report of the Port Medical Officer of London, dated September 1st, 1880, that there are still 348 foul outfalls within the limits of his district; nearly every one of which implies a distinct violation of the Rivers Pollution Act. As to the condition of things below Barking and Crossness, the writer of this paper has denounced it too often in this hall, to make it other than a thrice-told tale to his audience. It may be stated, in the interest of navigation, before we quit the subject of the Thames, that the dredging operations of the conservators during the past few years have only made the lack of water more conspicuous.

Purification.

The last branch of this inquiry is conservation for the purposes of purification, and the preservation of fish as food for the people. It is often said that purification is a misnomer, that it is impossible to purify water once polluted by sewage, and that fifty miles of river flow would not suffice to destroy by oxidation the germs of infection, where they exist. When I speak of purification, let it be understood that I mean "comparative purification" only. If the allegations above mentioned are well founded, it would appear to be the logical sequence of such opinions held in high quarters, that our rivers should not any longer be the sources of water supply for the people, and that the Thames and Lea must be unfit for the supply of natural food. That they are polluted by sewage no one can dispute, and in the eyes of sanitary enthusiasts, the baneful results of that contamination become more patent every day. But the Government measure expressly provides for the storage of water for drinking and other purposes, and the new Conservancy Boards may sell the water thus stored from time to time; this at once involves the power to clarify and purify as far as practicable the water to be stored, and, consequently, we find that both measures provide for the enforcement of the Rivers Prevention Pollution Act, 1876, conferring all the powers of a sanitary authority for such purpose. To those who know how far that Act has fallen short of the promise of its inception and enactment, this is indeed a step in the right direction, and the appointment of a free, fearless, and incorruptible authority to insist upon obedience to that Act will redeem it from the reproach hitherto cast upon it of a lame and impotent piece of legislation. In November, 1877, the Local Government Board recommended this Prevention of Pollution Act to the attention of all sanitary authorities throughout the kingdom, but the sanitary authorities turned a deaf ear to the suggestion, and when the Act came into full operation at the beginning of 1878, it was found that in the rural districts, the owners of small tenements upon the Local Boards took good care that the

rates, for which they had compounded, should not be augmented at the bidding of Government Inspectors or local sanitarians; whilst in the towns the manufacturers themselves, who were the principal delinquents, usurped the reins of local authority, and with sullen immobility declined to spin the rope for their own impending execution. Thus the manufacturers themselves being the most flagrant offenders against the obnoxious Act, it is no matter for surprise that they showed no alacrity in enforcing its provisions. When these measures receive the sanction of Parliament, we shall find a momentous change for the better throughout the kingdom. Men above the petty temptations of self-interest, and eager only for the common good of rich and poor alike, will intervene, under these Acts, to stay the continuance of old and to prevent the establishment of new sources of pollution; and who can doubt that that intervention is imperatively required? Sewage contamination, in its worst form, is poisoning the fish of every river, from the Tay to the Dart, and the precious food of the people perishes, choked by the refuse of cloth and other factories run to waste in every river pool. Costly manures are carried away, and their most valuable constituents lost in solution in their progress towards the sea; and when we reflect that fifty loads to the acre is no uncommon dressing in some parts of the Thames valley, we contemplate this waste of fertilising material with dismay. This becomes indeed "matter out of place," and that which was intended to enrich the lands, avails only to defile the waters. If this be a calamity incident to high farming and scientific cultivation, if this be beyond the help of human skill, it is serious matter for our consideration, how far we are justified in storing river water, at all events, on our lower reaches, for the use of man? In the upland valleys it may be possible to obtain water of sufficient purity from the rills and brooks. In this regard, the measures will be useful, and are worthy of all support. The pollution of rivers, by the refuse of mills and manufactories is, however, the *pièce de résistance* of sanitary progress. It has baffled the energies and perplexed the minds of economists, and we can paraphrase the celebrated line of the poet, "Theirs is the respect which makes (pollution) of so long life." Every Government fears to plunge into the slough of despond, and influences inside and outside Parliament have combined to postpone the question to a more convenient season. It is not wise to harass interests, especially commercial interests, just on the eve of a General Election, and gratitude for political support, or favours to come, make men wary of giving offence during the existence of a Parliament. But the logic of facts is too strong even for political ties, and the Court of Chancery steps in to vindicate the rights of riparian owners, even where the Legislature halts in providing a remedy. We hear a monotonous tale of injunctions and informations by the Attorney-General, on every side there comes a cry for help to arrest the vengeance of the law, and mills and factories in some of our most important industries have the possibility of extinction pending over them. From the Calder, from the Ribble, from the Medway, and from the Dart, importunate millowners, in their emergency appeal for help—financial and scientific—to save them from the threatened injunction. Fortunately, it has come to pass in the very nick of time, now that the Government have resolved to enforce compliance with the law, that in the same Parliament which is about to give the powers of compulsion to new Conservancy Boards, a Bill has been introduced, and read a first time, in the House of Lords, which offers a way of escape to those who care to seek it. This Bill is called the Manufacturers' and Millowners' Mutual Aid Association, and our Chairman, to-night, is one of its most zealous promoters, representing as he does interests largely identified with the commercial activity of Yorkshire, and suffering from the pollution of one of their largest rivers. The objects of the Bill are simple, viz., to provide the means for enabling manufacturers and others to comply with the provisions of the Rivers Prevention Pollution Act, 1876. "It is capital we want," say the mill-owners throughout the country, "science and engineering skill alone will not suffice, the experience of the past has taught us to utilise our waste, and we have taken to heart the lesson. We can retain that waste, which is really wealth disguised, if we had the capital to erect the necessary works and machinery; we only want time and the forbearance of the Government for a short while longer to lift us over the dead centre of our difficulties."

The effect upon our rivers, if this resolve were carried into action, would be immediate, and the undertaking of this company becomes, in that respect, an enterprise of national importance. It seeks powers to lend money, and supply the means which scientific skill and experience have disclosed, to keep pollution in the form of mineral and factory refuse out of our rivers, and to convert it to use and profit. The provisions of the Bill are analogous to those of the Land Improvement Act, furnishing a means of judicious investment, secured by the best of all assurances, in the development of our commerce and manufactories, and the improvement of mills and similar premises by outlay of capital to the mutual advantage of both landlord and tenant. The loans will be repaid over a period of years with interest, and the series of instalments will become a charge upon both land and premises thus improved, until final redemption. Such a measure as this is but a corollary to the original Act, and, with the co-operation of the Local Government Department, whose work it is designed to supplement, it will become an instrument in the hands of authority to compel the observance of the law. To Conservancy Boards and other similar corporations it will be a welcome ally, and will afford a ready reply to the manifold excuses which have become the stereotyped apology for every delinquency. "If, sir, you have the will to comply with the Act, there is the way," will be the cogent answer to all such protestations.

We must go back to the times of the Tudors for the first Conservancy Act, and it may be left to the Victorian age to complete the series. We accept these measures gladly for the good that is within them, and as an earnest of still better things to come. Meanwhile these Conservancy Boards, which they propose to constitute, have one distinguishing merit, they are thoroughly representative bodies, based broadly on the will and necessities

of the people, and they will be sustained by co-operation of all classes, urban and rural, for the common good. They will provide for drainage of all lands, high and low, inland or adjoining the sea, and under them the interests of owner and occupier, mill-owner, and merchant, will be equally protected with unity of purpose, and economy of administration. The evil of splitting up the country into partial jurisdictions, and the proverbial fate of divided councils, is thus avoided.

These are great gains, and we hope that the new-born zeal of our legislators will not cool; that Parliament will rise to the height of the great argument, nor stay its hand until the neglect of generations has been repaired.

DISCUSSION.

Admiral Sir Frederick Nicolson, Bart., C.B., as chairman of the Thames Conservancy Board, thought he ought, in justice to that body, to say a word or two. The question was one of complexity, and it was very difficult to make clear in a short time the legal position of the various bodies which had to do with the Thames. The portion of the river above Staines must always be divided from that below, the latter having been in the hands of the Corporation of London for many years; but in 1857, the Conservancy Board was constituted, and that portion of the river was placed in its hands. In 1866, the river above Staines was found to be in such a lamentable condition, that it was necessary to place it in the hands of some governing body, that being the portion where the greatest difficulty with regard to floods arise; and it was then placed under the Conservancy Board, which had an additional number of representative members added to the Board. With regard to the navigation, the Conservators had already spent about £100,000 above Staines, in large repairs and new works; and the locks and weirs, which were crumbling to pieces, had now been nearly all repaired. Simultaneously with this, attention had also been paid, as far as possible, to new weirs, in order to mitigate floods. Only a few months ago a new weir had been built above Henley, which received a very critical examination by a very distinguished officer of Engineers, who had had charge of irrigation works in India, and who acknowledged that it was a most excellent weir for the purpose. But there was always this difficulty, that the moment anything was done which improved the lands above, those below began to cry out for the same advantage, and so they went on from one expenditure to another, until they came to the end of their purse, for money was, after all, the great key to many of these problems. As to navigation, it was quite true, as Mr. Cresswell had said, that owing to the competition of railways, it did not increase as it might; but above Staines it had been much improved. Within the last two years they had placed a steam-dredger on the river, and were gradually clearing away many old obstructions, which no hand-dredger could deal with. Besides the Thames Conservancy, there was another body, called the Thames Valley Drainage Commissioners, which arose in this way. In 1870, the Conservators had a Bill before Parliament, and were anxious to do something to improve the district around Oxford. Owing, however, to reasons which he need not go into, the landowners thought they could do the work better themselves; the Conservators had to withdraw certain clauses from the Bill, and, a year or so afterwards, an Act was passed constituting the Thames Valley Drainage Commissioners. Their jurisdiction extends from fourteen miles below Oxford to a long way above Cricklade. They had had great difficulties to contend with; they had spent a great deal on preliminary surveys, and got an elaborate report from Sir J. Hawkshaw, suggesting an expenditure of £120,000 as the only thing which would cure the evils; upon this they were rather alarmed, having already rated the owners and occupiers about 4s. an acre for preliminary expenses. At the present moment, however, the Thames Conservancy were in correspondence with them, and were not without hopes that, if some means could be devised for raising money, something more might be done for that part of the river. There was one source of obstruction which they had no power of dealing with, and that was the old country bridges, which very often were obvious causes of floods. He could only say that, as far as their powers and means went, the Conservators had done their best, aided by their experienced engineer, to mitigate the evils of floods. With regard to purification, there was again a certain amount of complication. The Conservators had large powers, but within the metropolitan area, from Chiswick to Crossness outfall, the river in that respect was under control of the Metropolitan Board of Works. Above Chiswick and below Crossness the powers of the Conservators were very large; and he was glad to be able to say that above the intake of the water-works for supplying London, there was no sewage flowing into the river. The various local authorities had been induced, some at a large expense, to construct works to divert all the sewage, the last works completed being those at Oxford. The Conservators have monthly reports from their inspectors, who were constantly visiting the works, and with regard to the Thames itself, they were all satisfactory. With regard to the tributaries, there were certain small sources of pollution which they had been looking carefully into during the last few years, because, under the Act of 1878, they had power with regard to pollution over the tributaries of the Thames to the distance of ten miles, and in almost every instance they had stopped obnoxious matter flowing into them. But they were met at all points by legal difficulties. Only the other day they had a case on the Colne, where they proved clearly that the matter was obnoxious, that it went into the Colne, and that in four hours, whatever went into the water, would reach the Thames, yet the magistrates held that they had not proved, in the words of the Act, that "it was likely to go into the Thames," and the summons was dismissed. He did not like to touch on the question of the outfalls at Crossness, but they had had a very expensive arbitration with the Metropolitan Board of Works, costing them about £10,000, in which they were unsuccessful, because they were limited there to the question of navigation, and could not go directly into the question of pollution. Could that question have been raised before the arbitrators, the result would have been different.

Mr. Willis-Bund (chairman of the Severn Fishery Commissioners) said his Board did not look forward to either of the Bills to which Mr. Cresswell had alluded with much pleasure, and his own opinion was that they would make matters worse than before. He spoke both as a landowner and resident; for as a lawyer he should welcome both measures, as he foresaw they must lead to a vast amount of litigation. In fact, he could not have drawn a Bill more favourable to the interests of the profession than that introduced by the Government. One strong objection was to a new authority being created, seeing that they were already choked with authorities—Drainage Boards, Navigation Commissioners, and the Board of which he had the honour to be a member, which did what it could, with limited powers and means, to prevent the pollution of rivers. Experience showed that where there were several distinct Boards, they would only talk and quarrel, each questioning the authority of the others. He objected both to the constitution of the proposed Board, and to the powers to be given to it. The Bill stated that due provision should be made for the representation of owners, and yet it was possible to have a Board with no owners at all upon it, while at the same time they were to pay the expense of the

whole work. There must, in fact, be a large amount of taxation, and very inadequate representation. He also objected to the classification of lands. He could understand two classes of lands—those which were benefited, and those which were not; but he could not understand a third class between the two. Of course, all those which were benefited ought to contribute to the expense, but it was impossible for a Local Government Board Inspector to divide a watershed like that of the Severn in a satisfactory manner into these three classes. In the midst of the uplands, there were lands subject to floods, and in the lowlands there were portions which were not damaged by floods, and these ought to be classed with the uplands. Again, the Bill proposed to give power to tax every acre of land in the country—because all land was in some watershed—and that was, in his opinion, a power which ought not to be given. What was wanted was a power to set to work at once to clear streams, and get rid of floods; but the powers proposed included the storage of water for sale and the construction of arterial drainage. As to the latter, he contended that it was a separate matter altogether, and the former ought to be left to private enterprise. He thought the powers given should be limited in the first instance to inspecting and reporting, and calling on the owners to do the necessary works, and in default the Board might do them. In addition, some system of communication, such as had been suggested, by which preparations could be made in time for getting rid of the surplus waters could easily be devised. But instead of that a much more ambitious scheme was prepared, which would lead to a deal of litigation and expense, much of which would be thrown away. He had seen many attempts to carry out the Rivers Pollution Act, and he quite recognised the necessity for some public body being formed for doing this, but here the Bill fell far short of what was required, and he hoped when it emerged from committee it would be considerably extended, so that the Board might act in a more summary way—something like an injunction in Parliament to stop any pollution. If you had to write to the Local Government Board, and take first one step and then another before doing anything, the mischief was done. There was a town near the source of the Severn where a solid pollution was taking place, filling up the bed of the river, and his Board determined to take proceedings, but, in the first place, they had to give the offender two months' notice. He replied, that in two months he should have done all he wanted. When the time was up, they took proceedings in the county court, but the mischief was then done, and as the county court judge adjourned the case for two months more, in order to consider the Acts of Parliament, he advised his Board to compromise the matter, and not spend any more money on what was already done. What was wanted was power to interfere sharply and decisively when a pollution was being committed, or about to be committed, not simply to enter into a long correspondence with the Local Government Board.

Mr. Wolstencroft thought it would tend to the prevention of floods if the rain-water which fell on each house were utilised for domestic purposes, which might be done by rejecting that which fell first and washed down the impurities.

Mr. H. Noel asked Sir Frederick Nicolson if the sewage of Reading, Windsor, Oxford, and other towns on the Thames did not pass into the river, what became of it?

Sir F. Nicolson said it was disposed of chiefly by irrigation. The solid particles were applied to the land, and the Conservators had a careful investigation made of any overflow which might pass in. They were assured by the chemists, who analysed any samples about which there was any doubt, that they were sufficiently pure to go into the river.

Mr. Noel said he was one of the Conservators of the River Lea, and he might make identically the same statement as the chairman of the Thames Conservators had made, with regard to the Thames above the intake of the water companies, and in the same sense. He hoped, therefore, Mr. Cresswell would be able to withdraw the statement he had made about the water of those rivers not being fit for the consumption of the metropolis.

Mr. G. J. Symons, F.R.S., said he was sure Mr Cresswell would agree with him that 1880 was not by any means the first year in which floods had been conspicuous. There had been half a dozen exceptionally wet years, which led to exceptional floods, but he hoped it would be recollected in the House, that this was only a temporary phenomenon, and that there was no reason to suppose that the distribution of the rainfall had permanently changed from what it had been for the last 150 years. In all probability, just as they had had successions of dry years and of wet years in the past, so it would go on in the future, and he hoped the arrangements now proposed would not go too exclusively on the hypothesis which just now prevailed, that water was a nuisance, or they would soon be crying out in the opposite direction. In 1868, there was a terrible outcry, especially in the Midlands, that no end of damage had been done by draining too much, for the land was so dry they could not get any grass to feed the cattle. He was very glad to see the announcement in the *Times* with regard to the completion of the Ordnance Survey, and could not understand why there had been so much delay, unless the Department had been devoting too much attention to the survey of Palestine and the measurement of the Pyramids, and neglecting duties more important nearer home. He did not agree that railway communication had rendered water navigation useless, and hoped it would not be the case, because the competition of canals was most important as a check on the charges of railway companies. There was no doubt it would have been much better if London had been sewered with smaller sewers; but, after all, he did not think Londoners would like to see the whole of the rainfall, with all the filth from the streets, following merely the natural channels, which meant, he supposed, down the sides of the streets. If such were the case, it would not be very pleasant to cross Pall-mall, with all the filth from Regent's-park, Portland-place, and Regent-street running down. He did not pretend to be lawyer enough to have gone through these Bills carefully, but, looking at it as an outsider, he thought they would come to grief over the question of rating. As was generally the case, local and personal interests would come to the front, and, instead of fighting the matter on the engineering merits, it would be fought out on the question whether parties should pay a high rate or a low one. One thing, however, seemed to be overlooked, that the highlands were the real sinners; they produced the bulk of the water, and why should not they help to pay for getting rid of it. There was no doubt in his mind that, if the rivers were properly cleared out, a much more rapid discharge for flood-water would be provided. Again, in old times, it was understood that much land on each side of a river was wash-land, liable to be flooded, in times of wet weather, but now-a-days people built upon this land, and then raised a great outcry when they were flooded. He was glad to hear the suggestion as to opening sluices, &c., and having telegraphic communication at the different weirs, and locks for that purpose; it was one he had made some years ago, but it was only following the example of the French, who had done it long ago. But even assuming the river to be quite free when a flood came down, it would not make so very much difference. The Thames Conservators were always wanting funds, and he hoped some means would be formed for giving them larger means to carry out their operations. As to the fish, he

thought Mr. Cresswell must be a fisherman, or he would not attach so much importance to this point, for any amount of food they might obtain from the Thames in this way would be as nothing compared to the quantity which was constantly thrown away, simply for the purpose of keeping up prices at Billingsgate. Mr. Bund had objected to landowners being taxed to provide water-storage, but on the other hand he had heard complaints that those at the head of a river would be able to store up the water, and to sell it to towns lower down at a profit.

Mr. Baldwin Latham agreed that the multiplication of authorities, as proposed by the Bills referred to, would not tend to a useful result. On the other hand, there were great objections to giving conservancy powers to urban and rural sanitary authorities, they being the chief sinners with regard to pollution; and any Central Board elected by the minor Boards would be open to the same objection. The question of taxation would be a very difficult one. It was quite true that the highlands were the flood producers; Sir J. Hawkshaw's rule was that the rainfall increased 3 per cent. for every 100 feet of elevation, but, in 1879, the rate of increase in many places, according to his own observation, was 10 per cent., and scarcely anywhere under 6 per cent, which gave some idea of the enormous amount of floods in that year. Last year the increase had not been so great. But though this was true, the lowlands were valued, taking the contingency of floods into account, and, therefore, if the whole area were taxed, the lowlands would be benefited at the expense of the others. Therefore, in any public measure for improving the lowlands at the general expense, the Conservancy Boards should have power to acquire all lands at the present rental, so that hereafter the district which was to be taxed should have the benefit of the improvement, and not allow them to be pocketed by the landlords. The pollution of rivers was a matter which demanded urgent attention, and though they had heard that the Thames was entirely free from pollution, he thought the statement must be accepted with some reservation. People had very different notions as to what constituted pollution. On the River Lea the works were not so perfect as in the valley of the Thames, but even there, in many places there were large traps and overflows, called storm-water overflows, which in times of heavy rain discharged the sewage of the district into the Thames. There were also many tributary districts, which at the present time were undrained. This question of purification was of great importance, though it was much lost sight of in rainy seasons, these being the most healthy. In fact, the health of London was in proportion to the quantity of water which passed down the Thames. The Bill to which Mr. Cresswell had alluded, in which he was in some degree interested, was intended to put manufacturers in the same position, with regard to utilising their sewage and refuse, as local authorities were, giving them power to borrow money for the necessary works, and spread the payment over a number of years.

Sir F. Nicolson said he was quite aware that there were many storm overflows within the metropolitan area; and there, no doubt, sewage came into the river; but, as far as he knew, there was nothing of the kind above the intakes of the water companies.

Mr. Peregrine Birch said the Government Bill ought to be called "The Surface-Water Disposal Bill," for at present no power existed for any authority to deal with the surface-water; and that and the sub-soil water was the great difficulty. Some such measure as that now contemplated would, therefore, be of the greatest use; and it would be advisable not to make the district too large; for it was very difficult to get a large area of one opinion. If the rural or sanitary authorities were not large enough, they could combine, as they did for sanitary purposes. He should certainly advocate power being given to an authority for a part of a basin as well as for a whole basin. He did not believe in the arrangement of lowlands, midlands, and uplands, but whatever divisions were made should be arranged before the district was formed, or, as soon as they began to discuss who should pay, the majority of the ratepayers would come to the conclusion that no work at all was necessary. He was pleased to hear, on the authority of Mr. Sewell Read, that subsoil drainage had not increased floods, for that had always been his opinion. He had no doubt, either, that a great deal of the belief that floods had so much increased of late years was owing to the improved methods of communication, for there were records of floods 50 and 100 years ago, quite as high as anything we have had lately, and if so, the area covered must have been as large. He did not think much would be gained by telegraphing, for he had seen boats rowed up the Thames over the weirs, so that if they were removed altogether it would not make any difference in the level of the water. He had sketched out five clauses for enabling sanitary authorities to conctruct works for the removal of surface and subsoil water from their districts, which he suggested should be added to the Government Bill.

Mr. Cutler remarked that one point of some importance had not been touched upon at all, viz., the importance of rivers as a source of power. From Oxford to Teddington, there was a fall of 70 or 80 feet, and the power thus at command was utilised to some extent, but not nearly so much as it might be.

Mr. Grantham said he was appointed an inspector under the Land Drainage Act of 1861, and since then he had inspected many districts, where questions which this Bill dealt with would arise. The provisions were very complicated, and his experience led him to believe they would not work. At the end of his evidence, before the Lords' Committee, in 1876-77, were two tables, one of which classified all the rivers of England, according to their areas, and they varied from over 6,000 square miles to three. The medium-sized areas it would be comparatively easy to deal with, but the very large and very small ones would present great difficulties; the small ones would have to be amalgamated, and the larger ones divided. He was the inspector appointed to fix the boundary of the Upper Thames Valley Drainage; a survey was made on the 25 inch scale, which was afterwards reduced, and a contour line was put on it 5 feet above the highest known flood, and that was fixed as the limit. As to the taxation, there was a great mistake made in the Bill, the true principle being to tax the lands according to the amount of benefit derived from the works undertaken. In Ireland this was arrived at by a valuation of the land before and after, and though this would be very expensive, still it might be done by the aid of local knowledge.

Mr. Cresswell, in reply, summed up the principal points in the discussion, with most of which he agreed, and he expressed himself much gratified that almost everyone who had taken part in it was a representative man. He was much delighted at the statement made by Sir Frederick Nicolson, in which he was followed by Mr. Noel, but he thought those gentlemen were a little too confiding. If inquiry were made of the mill-owner on the Kennet, just where that river entered the Thames, near Reading, as to the condition of the wate after a heavy rain, he did not think his report would be so satisfactory as to the perfection of the sewage works. Mr. Bund was quite right in saying there would be an enormous field for litigation, and that he wished to avoid. With regard to the Lea, he heard at the Kingston inquiry, the evidence of Major Lamrock Flower, who lived in the Lea Valley, and he gave a very unsatisfactory account of it, and talked of "back doors," which was a polite phrase for certain sluices which

were sometimes opened at night, when the Conservators were not on the look out. He admitted the force of Mr. Symons's objection to the whole of the filth of London streets being washed down the gutters, but that might be met by proper scavengering, and, in practice, the storm water would not be carried in open gullies, but in covered channels much smaller than the *cloaca maxima* now existing. There was no doubt, as Mr. Symons pointed out, that a great deal of the outcry against floods arose from people's own folly in building in improper situations. For instance, Nottingham, 100 years ago, had 7,000 inhabitants, and now had 120,000, great part of whom lived in rows of dwellings along the side of the Trent, built on land which was formerly flooded half the year. As to the fish, he quite agreed that the disgraceful proceedings now common ought to be stopped, but when that and all other abuses were abolished, there would be no need to have discussions in that room any longer. Mr. Latham's valuable experience as to storm overflows showed the importance of separating the rainfall from the sewage wherever practicable; it was from these storm overflows that the real sources of contamination were derived; and the tributaries of the Thames were not by any means so pure as the Conservators imagined. However, when they heard of the decision of the magistrates at Uxbridge, one could only wonder how any Board could carry out its duties. Mr. Cutler had certainly called attention to an important omission, but, as had been stated at the beginning of the paper, he had been obliged to omit a great deal he should have liked to bring forward. The difficulties connected with taxation to which Mr. Grantham had alluded were present to his mind, and he had, therefore, suggested that they should be adjusted by Parliamentary authority, and not left to local jealousies and disputes.

The Chairman moved a vote of thanks to Mr. Cresswell, which was carried unanimously.

MISCELLANEOUS.

SILK-PRODUCING BOMBYCES REARED IN 1880.

By Alfred Wailly

(Membre-Lauréat de la Société d'Acclimatation de France).

As it has been seen in my report, published in the *Journal of the Society of Arts*, Feb. 13th and March 5th, 1880, the cold weather in 1879 had the most disastrous effect on the rearing of exotic Lepidoptera. In 1880, the fine and warm weather we had during the month of August and part of September allowed of the successful rearing of several species in the oper air; but the cold and wet weather, lasting till about the end of July, had the same effect on most species, as in 1879. The moths of *S. Promethea*, for instance, which generally emerge at the end of June and beginning of July, had not all emerged before the end of August; one, *S. Cynthia*, emerged on the 7th of September. Excepting a few, the Indian species did not emerge at all. Four *Actias selene* moths were obtained at intervals; the others remained in the pupa state. No pairing could be obtained. The same failure attended *Attacus mylitta* (Himalaya race), of which I only obtained nine moths, from the 13th of August to the 7th October, giving me no chance of obtaining fertile ova. A singular fact respecting *Attacus mylitta* is, that some cocoons placed in a hot-house at a gardener's, in April, did not produce any moths till August, too late to rear this species, if fertile ova could have been obtained.

At the end of February, 1880, I received from Calcutta 900 cocoons of *Attacus mylitta* (Himalaya race), about 750 of which had died in transit, but none had emerged. Later on, April 19th, I received from Major Coussmaker a tin box containing 100 *Mylitta* cocoons of the Bombay race, more than two-thirds of which had emerged on the way. The tin box had evidently been kept in too warm a place, and the metal had quickly communicated the heat to the cocoons. From the remaining cocoons of this Bombay race I obtained several fine moths, from the middle of May to the beginning of July, but, as with the Himalaya race, no pairings took place, the weather being too unfavourable. I had to keep them in a room.

For two years I have had a series of disasters, owing to various causes. The greatest difficulty is to obtain the cocoons alive from abroad; the next great difficulty is the struggle against the climate, which has been my greatest enemy here during the last two years. Artificial heat, unless pure air and a free ventilation can be obtained at the same time, cannot replace natural heat. The reverses experienced during the last two years in my attempts to reproduce and rear these splendid silkworms and other Lepidoptera have been beneficial to me in one respect—they have given me valuable information, which I should never have acquired had everything succeeded according to my wishes, although I sincerely hope these fatalities will not occur again, at least on such a large scale.

The species of silkworms which I placed on trees in my garden during the magnificent month of August, were *Cynthia*, *Pernyi*, *Prometheus*, *Cecropia*, *Polyphemus*, *Luna*, and *Pyri*.

The *Cynthia* worms thrived remarkably well on the Ailanthus trees; so did a few *Promethea* on a small lilac tree, the first time I tried the latter species in the open air. I never remarked that the sparrows destroyed any *Cynthia* worms; the *Promethea* worms (a very closely allied species) were equally spared by them. But it was not so with respect to the other species, of which the sparrows made a wholesale murder this last summer (1880). Excepting the year 1879, when the rearing of most species was absolutely impossible in the open air, I had previously succeeded in obtaining cocoons of several species besides *Cynthia*, although I could not protect them from their terrible enemy, the sparrow.

My object in thus rearing, or attempting to rear, these silkworms on trees in the open air, is, of course, to test what we call their *rusticité*, i.e., their hardiness or capacity to resist the English climate; but birds must certainly be guarded against.

Actias luna (North America).—This species I bred this year for the first time, and I obtained a complete success. I think it is one of the easiest species to rear. The larvæ were fed on walnut, some of them being kept under large bell-glasses, till they formed their cocoons, which are of very thin texture. This species is of no value as a silk producer, and cannot be called a silkworm, but it is very beautiful; the perfect insect, like the Indian *Selene*, resembles a swallow-tail butterfly of a yellowish-green; it is smaller than *Selene*. Other *Luna* larvæ thrived equally well on a nut tree in my garden, with *Polyphemus* and *Cecropia*, but, as stated before, the sparrows destroyed them all, when in the third and fourth stage. I had a large quantity of *Luna* cocoons from America, and the moths emerged from the beginning till about the end of June. I obtained twelve or thirteen pairings. In the first two stages there is a striking difference between the larvæ of *Actias luna* and those of its Indian congener, *Selene*. *Selene* larvæ in the first stage are dark red, with a broad black band across the middle of the body; in the second stage, they are of a lighter red, without the black band; in the other stages they are green like *Luna* larvæ. *Luna* larvæ are green in all their stages; in the first stage, of light or whitish green. When large, the tubercles on *Selene* larvæ are bright yellow, and on *Luna* larvæ, of various shades of red or crimson.

Attacus aurota (South America).—On the 5th of June, 1880, I received from French Guiana a box containing

82 cocoons of this splendid species (the South American *Atlas*), and 18 smaller cocoons of a species called *Bombyx hesperus*. The latter had all been attacked by dipterous parasites. The cocoons of *Bombyx hesperus* are similar in shape and size to those of *Cynthia* (the *ailanthus* silkworm), but they are of a much darker colour. The moths of *Attacus aurota*, of a rich and silky brown, with a triangular window on each wing, are smaller than most of the various races of *Attacus atlas*. The *Aurota* cocoons, of a brilliant golden or silvery silk, are open at one end, and similar in shape to those of *Atlas*. A certain number of the *Aurota* moths had emerged during the voyage, but the remaining live cocoons were in good condition, and produced from the 12th of June to the 19th of August, splendid and perfect moths, which unfortunately refused to pair, the weather being too cold for this equatorial species. On the evening of the 2nd and 3rd of July, the weather being then very cold, a fire was lighted in a large room in which I had a number of cages containing *Aurota*, *Mylitta*, *Selene*, and other moths, but all to no purpose for these three species. At the "Société d'Acclimatation," in Paris, they also failed to obtain pairings from the *Aurota* moths which had emerged from the cocoons I had sent to the secretary of that society.

Attacus aurota is found in Brazil, and, very likely, all over equatorial America. Various names are given to different races of *Aurota*, as if they were distinct species. *Attacus speculifer*, found in Brazil, is so much like the true type *Aurota*, that it seems but a variety, if it be even a variety. My own *Aurota* (Guiana race) is rather more like *Speculifer* than the one given as the true *Aurota*. All three, in my opinion, are one and the same species. This multiplicity of names is sometimes bewildering. At the British Museum, for instance, among the Indian species of the genus *Actias*, we find *Actias mænas* and *Actias leto*, side by side, it is true. Now these, according to an experienced American entomologist, Herman Strecker, are the same species: *leto* is the name given to the male, *mænas* that given to the female. The male is blotched all over with reddish brown, the female is plain green, at least such as I remember to have seen.

The *Aurota* I received has, every year, six generations in French Guiana. Such is the effect of equatorial heat on these insects, whose life is as ephemeral as it is active. How different from insects found in cold countries, which sometimes require three years to reach the perfect state! I have seen cocoons of Indian species, such as *Mylitta* and *Selene*, hybernate twice, and even three times, under the influence of the English climate.

To conclude this notice on *Aurota*, I will translate and quote a few passages from my French correspondent's letters:—"In our French Guiana we have five distinct species of silkworms, but I only have time to rear two, which I do on a hedge in my garden. Our silk-producing larvæ, have regular, pacific habits, which make the rearing easy and attractive. The *Aurota* moths emerge one month after the formation of the cocoon; the pairings here take place in the open field, and the females lay over 600 eggs each; eight days after the larvæ hatch, and in 20 days the cocoon is formed. *Bombyx hesperus* forms its cocoon 15 days after the hatching of the larvæ, and the same operations are renewed every 60 days for *Aurota*, and every 52 days for *Hesperus*. We can therefore produce six crops of cocoons every year, and these crops would have no other limit but the extent of the plantations, the foliage of which is renewed twice a year. So, you may think, how inexhaustible would be such a production of silk, if a European company seriously took this industry in hand. *Bombyx hesperus* and *Attacus aurota* live on the same trees, and both will live, I think, on the *Ailanthus*, *Aurota* lives here also on the orange tree, and on the *Eucalyptus*."

Attacus atlas.—In 1879, Mr. P. H. Gosse, F.R.S., of Torquay, published a long and interesting memoir on *Attacus atlas*, in which a very minute description is given of the egg, the larva in its six ages, and then of the cocoon and pupa. Herr L. Huesmann, of Nienberg, in Hanover, has also written a memoir on *Atlas*, which has appeared in the "Isis" of Berlin on the 9th 19th, and 23rd of September, 1880.

In one of my reports on silk producers, I mentioned that, in the year 1878, I had a quantity of live cocoons of *Attacus atlas*, but the moths having commenced to emerge in the middle of July, when I was about to start for Paris, I was unable to rear this species. In 1879, I had no cocoons nor ova of *Atlas*, but, in 1880, a French correspondent sent me sixty-five ova about the middle of August. The season being then too far advanced to give me any chance of rearing the larvæ here, I sent the ova to two correspondents on the Continent, keeping only twelve, to see when the larvæ would hatch, and how long they would live under a bell-glass. Both my correspondents failed to obtain any satisfactory results. One stated that the ova had not hatched, the other wrote to me that half of the eggs had not hatched, and that the larvæ obtained had all died in a very short time.

With my twelve ova, I obtained five larvæ, which hatched on August 22nd. Three died in first and second stage, but the other two, strong and healthy, were in splendid condition on the 6th November, when they were sent for preservation. The weather had become very cold, the foliage might have failed at any moment, and the larvæ were too far from the spinning period to give any chance of obtaining cocoons; they had been in the fifth stage from the 5th of October (32 days) and showed no sign of entering into their last sleep previous to passing into the sixth and last stage. The larvæ were fed on a superior species of the common barberry (*Berberis vulgaris*), with large thick foliage. This food I found the best for them. The different stages took place as follows:—First stage commenced on the 22nd August, the second on the 2nd of September, the third on the 10th of September, the fourth on the 20th of September, the fifth on the 5th of October. The larvæ were five days in sleep before passing into the fifth stage in which they remained as above stated—32 days. Those bred in 1878 by Major Lendy, of Sunbury-on-Thames, were only one month from the time of hatching to the formation of the cocoon, but they were in a hot-house.

The larva of *Atlas*, when hatched, is black, with long, white, soft spines. In the subsequent ages, the larva appears almost entirely white; this is due to a white powder, which covers not only the tubercles but the greater part of the body, thus rendering a description of the larva rather difficult. In the second and third stages, the colour seemed orange on the parts of the body from which no farina was excreted. The larva of *Attacus cynthia* (ailanthus silkworm) is also covered—but not so thickly—with a white farina in its last stages. On removing the powder, the skin of the larvæ is green. Having only two atlas larvæ, I would not remove the powder, to see their colour, as I feared to run the risk of injuring or killing them. As is the case with other species, there are six rows of spines on the larva, the two rows on the top of the back being the longest; the two lateral rows are very small, and almost filiform. The farina on the four top spines is so thick that they look as if covered with hoar frost. In the fifth stage, the larva seemed of a yellowish green, the tips of the spines blue; the anal segment, which is blue, with small black spots, has on each side an orange-red ring. This is a very short and imperfect description of the *Atlas* larva, but a complete one is found in Mr. P. H. Gosse's "Memoir on the Great Atlas Moth of Asia." From a letter just received, I hear that, in 1880, Mr. P. H. Gosse had a complete success in the rearing of *Atlas* larvæ, from ova received in June, the result being a number of fine cocoons.

Attacus Pernyi (North China).—This most valuable oak silkworm, now thoroughly acclimatised in Spain,

where it is double-brooded, has been extensively reared in the United States of North America, during the year 1880, from live cocoons I sent to various parts. A correspondent in Illinois, writes that it was double-brooded there, and that he found some of the worms (which had left oak trees, the foliage of which had become dry and tough in consequence of the hot, dry, summer), feeding on hawthorn bushes, growing close to the oak trees. Other *Pernyi* larvæ were found on apple trees in a garden, where they reached an enormous size. In France some were reared successfully on plum. According to a statement of my Spanish correspondent, *Pernyi* is essentially an oak feeder, which will degenerate after a time, if fed on other trees than oak.

(*To be continued.*)

"MHOWA" OR "MAHWAH," AN INDIAN FOOD-TREE.

By C. G. Warnford Lock.

The problem of ensuring a sufficient food supply for India's millions, cannot yet be said to be satisfactorily settled, though much has been done to avert future famines. Some remarks upon the *Singhara* nut, a highly important article of diet among numbers of the natives of India, appeared in the *Journal* of January 31st, 1879 (No. 1,367, vol. xxvii., p. 174). An equally deserving subject is the produce of the *mhowa* tree.

The name *mhowa*, which is spelt by Europeans in at least a dozen different ways, is applied, it would seem, not only to *Bassia latifolia*, the most important species, but also to *B. longifolia* and *B. butyracea*, whose fruits are likewise edible. The singularity of the genus consist in the fact that, besides offering eatable fruits, their fleshy deciduous corollas are largely employed for the same purpose, and in point of fact, constitute a staple, and sometimes almost the only, article of diet available to the poorer classes of Indian natives during several months of each year. *Bassia latifolia* is abundant in all parts of Central India, and is cultivated in many other districts.

Towards the end of February or the beginning of March, as the crop of flowers approaches ripeness, the corollas, becoming fleshy and turbid with secreted juices, gradually loosen their adhesion to the calyx, and fall to the ground in a snowy shower. The duty of collecting the fallen blossoms is chiefly performed by women and children; at dawn, they may be seen leaving their villages, with baskets, and a supply of water for the day's use. Before the crop has began to fall, they take the precaution to burn away the grass and leaves at the feet of the trees, so that none of the blossoms may be hidden when they fall. The gleaners generally remain under the trees all day, alternately collecting the crop and sleeping, and the male members of the family visit the trees once or twice during the day, in order to carry away what has been collected. At night, bears, deer, and other animals visit the trees, to take their share of the crop. At early morning and late evening, the less frequented trees, on the borders of the jungles, attract numbers of jungle-fowl and pea-fowl. Cattle are also very fond of the flowers, and cows' milk has in consequence, at this season, a strong flavour of *mhowa*.

It often happens that the collectors come a considerable distance, in which case they erect, with the branches of the *sál* tree (*Shorea robusta*), a temporary encampment of huts, in which they live until all the crop is gathered in. In front of each of these huts, a piece of ground is made quite smooth and hard, for the purpose of spreading out the flowers to dry in the sun. When perfectly dry, they have a reddish-brown colour, and are reduced to about a quarter their original size, and half their original weight. It is a custom with some of the natives, before spreading the flowers out to dry, to pull off the ring of minute foliaceous lobes which crowns the fleshy corolla. It is very difficult to obtain any trustworthy statements as to the yield of the trees. A first-class tree, it has been said, will continue to shed its blossoms for 15 days, at the rate of 120 lb. a day; but this estimate is probably double what it ought to be. The rent of trees varies with their abundance in the district, the quality of the preceding rice harvest, and various other circumstances bearing upon demand and supply. The extreme prices ascertained by Mr. V. Ball, of the Geological Survey, to have been paid for permission to collect, in various places, were 2d. and 4s. The saved crop varies equally in price, the extremes being 120 lb. and 480 lb. for a rupee (2s.); but when, as is most frequently the case, the exchange is made in kind, the merchants give only a small quantity of salt, and 6 to 8 lb. of rice, for the maund (80 lb.) of *mhowa*. During the famine in Manbhum, a rupee would purchase only about 24 lb.

Some authorities state that two maunds of *mhowa* will furnish a month's food to a family of two parents and three children. It is, however, seldom eaten alone, being mixed with the seeds of the *sál* tree (*Shorea robusta*), or with the leaves of jungle plants; sometimes a small quantity of rice is added. When fresh, *mhowa* has a sweet taste, with an odour somewhat suggestive of mice; when dried, it presents some resemblance to inferior kinds of figs. Cooking renders it vapid, and utterly devoid of flavour. On distillation, the newly-dried flowers yield a highly intoxicating spirit, called *daru*, which is generally diluted with five to ten times its bulk of water, and is then sold at the rate of about 1d. a quart. Its odour is most offensive to Europeans, but British soldiers have been known to secure intoxication by drinking it with held noses. By careful distillation, it is possible to get rid of the essential oil which causes the unpleasantness. As much as six gallons of proof spirit have been got from one cwt. of the flowers. The rectified spirit, when placed in oak casks, takes a yellowish colour, and is preferred to high-class Irish whisky. Analysis shows it to be wholesome. From the seeds, is expressed a kind of oil, which is used for cooking purposes, for admixture with ghee (clarified butter), and for lighting and soap-making.

The tree thrives in poor stony ground, and might, therefore, be cultivated on land not available for other crops. Though the natives protect such trees as exist, they do not seem to take any steps to increase the number. The yield of flowers is proverbially regular from year to year. When dried, they will keep for almost any length of time. The large proportion of sugar (50 per cent.) contained in them has attracted the attention of agriculturists in this country, who see in them a valuable cattle food; and Messrs. T. Christy and Co., of Fenchurch-street, are already importing them for that purpose.

DRY FOGS.

Mr. John Aitken, of Darroch, Falkirk, has made a large number of additional experiments on the formation of fogs since the reading of his paper on "Dust, Fogs, and Clouds" before the Royal Society of Edinburgh, in December last. He then showed that particles of watery vapour do not combine with each other to form a cloud-particle, but that the vapour must have some solid or liquid body on which to condense. Vapour in pure air, therefore, remains uncondensed or super-saturated, while dust-particles, in ordinary air, form the nuclei on which the vapour condenses and form fogs or cloud-particles. The main conclusion which the author drew from his original experiments was that, "if there was no dust, there would be no fogs, no clouds, no mists, and probably no rain, and that the super-saturated air would convert every object on the surface of the earth into a condenser on which it would deposit." During the present month, he read a paper, illustrated by experiments, before the

Philosophical Society of Glasgow, on "Fogs and Atmospheric Dust," and in the following week he communicated a paper on "Dry Fogs" to the Royal Society of Edinburgh.

From experiments which the author had made, he had drawn certain conclusions, which were thus summed up:—1. That as regards quality and foggy condensation, there was dust and dust. Some kinds of dust had the power of determining condensation in an atmosphere which was not saturated air; and from other experiments it was probable that some degree of supersaturation was necessary before some other kinds of dust were active. In highly supersaturated air all kinds of dust would form nuclei and determine cloudy condensation, but in unsaturated air only some kinds were active. 2. That dry fogs might be produced by some form of dust in the air, such as sodic chloride (common salt), thus condensing the aqueous vapour in the air which was not saturated. 3. This condensing power or attraction which some kinds of dust had for aqueous vapour explained why our breath and condensed steam dissolved even in foggy weather. 4. That as the products of combustion of sulphur determined the condensation of water vapour in unsaturated air, and gave rise to a very fine-textured dry fog, they were probably one of the chief causes of our town fogs, as they had a much greater condensing power than the products of the combustion of coal. It was not claimed that Mr. Aitken's experiments proved that dry fogs in the country were produced by salt dust. The experiments only proved that salt dust could produce a dry fog. In a note appended to his paper, Mr. Aitken added that since making the experiments which had been described, the fog-producing powers of the products of highly heated chloride of magnesium had been tested, and were found to possess a much greater fog-producing power than any other substances with which he had experimented.

GOLD MINING IN JAPAN.

The Vice-Consul at the port of Niigata, in a recent visit to the gold mines, which are situated at Shimo Aikawa, on the upper slopes of a valley extending down to the shore through the town of Aikawa, states that these mines were first discovered in the year 1613, in the time of Iyeyasu, and have been steadily, though slowly, worked by manual labour till 1869, when the Government determined upon applying the foreign method of mining. Machinery was constructed, and in 1872 was in full working order. Three mines are now being worked—those of Ogiri, Torigoi (a quarter of a mile distant from Ogiri on higher ground), and Aoban. Gold and silver are found in all three, but copper prevails in the first two. Torigoi and Ogiri are imperfectly connected by a gallery, 3,000 feet in length, and a tramway between them is shortly to be laid down. The main shaft is sunk to a depth of about 600 feet, and is situated between the three. As the ore is brought up from the mines through the shafts, it is carried in trucks to sheds, where it is picked by women and classified into four kinds, thence it is conveyed on women's backs to the works, at the rate of 23 cents a ton. A tramway originally connected the mines and the works, but it was partially destroyed by a storm some years ago and has never been repaired. A new road for tramway and bridges, however, is in course of construction. First-class ore generally contains from 50 to 2,000 yen worth of gold, silver, and copper per ton. This ore is crushed, reduced to powder by the stamps, and ground up with mercury into an amalgam (the latter process taking eight hours). This amalgam is distilled and afterwards made into gold and silver ingots. The tailing or refuse parts of the amalgam still contains some metal, to the value of 15 to 20 yen per ton, and is sent to the concentrating tables, where the gold, silver, and copper are concentrated. These concentrations are afterwards sent to the smelting works where the ore is reduced to crude black copper by the action of heat. After the sulphur has been driven out by calcination, the crude mass is melted in flat furnaces with the addition of lead. The lead sinks to the bottom of the furnace with the gold and silver, and the copper is left behind. The smelting process is repeated three or four times. The lead is collected into a mass of about 20 tons cupelled by German furnaces, and after the lapse of 50 to 60 hours, bullion is extracted. This is made into ingots of 5 to 700 oz. weight. The refining is done at Osaka. Second-class ore contains from 30 to 50 yen worth of metal per ton, and is reduced to bullion by the same process as the first. Third and fourth-class ore are first crushed, made fine by the stamps, and subsequently concentrated by the tables. The concentrations are then reduced by smelting. The amount of gold and silver produced in the year 1878-9, amounted respectively to 2,195, and 91,713 ounces. Mr. Adachi, the superintendent of the mines, states that the total loss to the Government in working the mines, for a period of ten years, ending 1879, has been 240,126 yen (about £50,026). This amount, however, Mr. Adachi hopes to reduce in a few years. He proposes to erect a new steam-engine of 50 horse-power, 10 stamps and 6 amalgamating pans, and to make other improvements, the total cost of which he estimates at 83,000 yen (£17,291). The annual production is expected to be about 420,000 yen (£87,500), and the working expenses 300,000 yen (62,500). The persons employed in the mines number 1,080, including 120 women for ore picking. Miners working eight hours a day receive 22 cents, and the average wages of miners per day, for six months, has been 18 sen 3 rin (about 9d.); 80 women are employed for carrying ore, and 299 men in the workshops. Skilled workmen receive 25 cents per day of 12 hours, while in Tôkiô men doing similar work receive 40 to 50 cents. Inferior workmen receive 9 cents. The average wages of workmen for six months, have been 14 sen 7 rin per day (about 7d.). There are 41 overseers, including one superintendent, one foreigner, six engineers, and four clerks. The daily output of ore is about 20 tons, and about the same quantity is reduced. The total expense of reducing one ton, amounted, in the year 1879, to 21 yen 7 sen (about £4 7s.). In the percussion tables about 10 tons are reduced in 24 hours, and in the amalgamating pans about 9 tons daily. In addition to the mines of Ogiri, Torigoi, and Aoban, gold has also been found in small quantities at Takinosawa, about 12 miles from Aikawa, in the alluvial deposit of the bed of a river, and also at Nishi-Mikawa.

CORRESPONDENCE.

TRADE PROSPECTS.

In the Society's *Journal* of the 4th inst., at the foot of p. 193, Captain Bedford Pim, R.N., a pretty good authority in matters nautical, is reported to have said that "owing to the repeal of the Navigation Laws, 80 per cent. of our seamen were foreigners."

In the *Times* of the 7th inst. (p. 8), I read, under the melancholy heading of "Disasters at Sea," that 22 British vessels had been reported wrecked during the previous week (one of such vessels having been 54, and another 41 years old); that the total number of wrecks, British and foreign, for the present year (then little more than five weeks old) had been 295; that 112 lives had been lost, and that the approximate value of property lost had been £5,200,000, including £4,000,000 British.

In the *Times* of the 11th inst. (p. 10), also under the

same chilling title of "Disasters at Sea," I read that the *Bureau Veritas* reports, in part of 203 vessels of all flags lost (including, however, 16 missing) in December last, 93 English sailing vessels and 12 English steamers.

Cannot cause and effect be discerned to some extent in the several foregoing statements? Is there no connection between the "Babel of tongues" and nationalities, which must exist on board our ships, when four-fifths of the sailors are other than British (supposing the gallant and learned ex-member for Gravesend to be correct in his assertion), and the loss in 9 or 10 weeks of the $22 \times 93 + 12 = 127$ British vessels above referred to, and the loss in about five weeks of four million sterling of British property?

If, then, 80 per cent. of our merchant seamen are foreigners, how, in the event of a great naval war, could an adequate and reliable supply of British A.B. seamen be got out of the odd 20 per cent., to fill up, on the sudden, the complements of men required for the ships of the Royal Navy, and to man, and to fight, if need be, our great merchantmen?

Our fishermen, and life boat, and coast guard men are a noble set of fellows, but could they be spared away from our shores in the event of such a war? And how could our great carrying trade be safely conducted?

Is there not something rotten in the present state of things, and are not the enormous losses, as well as the high premiums paid for marine insurance, really borne as an Income-tax (so to speak) on commodities by the long-suffering British public? Would it not be instructive if a return were made by the Board of Trade of the numbers respectively, of British and foreign sailors on the books of every British vessel which should be wrecked or seriously damaged? A SALT'S SON.

GOLD IN INDIA.

Having attended the meeting on this paper, held on Friday, the 11th instant, I beg to make the following observations on the question of labour, raised during the discussion:—

That it would, in my opinion, be a mistake to send out a large number of Cornish miners to India, as they would give a deal of trouble, and do little work. Nor is it necessary to do so, seeing that native Wuddars can be obtained, who are skilled in the use of jumpers and drills, and in blasting operations, also in the splitting of boulders and rocks by hammers or rows of wedges, and that they quickly understand any system that may be adopted for carrying out works.

That the only Europeans required would be men suitable to have the supervision of the work, with a superior officer to organise and direct.

This opinion is formed from my experience in India during the years 1866-7-8, when I had chief charge of the construction of the railway works between Koolburga and Raichore, about 200 miles north of Mysore.

When operations were commenced, not more than thirty or forty men could be obtained, and these were unaccustomed to the kind of work, but within a year, however, from eight to nine thousand men were got together from various districts, so that no difficulty as to labour need be apprehended.

JOHN ROBINSON, Civil Engineer.

Lewes and East Grinstead Railway,
Engineer's-office, Kingscote, East Grinstead,
Feb. 14th, 1881.

PREVENTION OF FLOODS.

In viewing the face of the country, one is struck with the narrow, tortuous character of the water-courses and small streams in many places, also, weed-grown and choked with gravel. Much good might be effected on every farm if these ditches, water-courses, gulleys, &c., were, as far as possible, straightened; but, at all events, carefully dredged, widened, deepened, and (where necessary) embanked. It would be necessary to resort to dredging at intervals of about four years, even when the work was well done at first; in fact, constant attention would be needed as a consequence of the winter's frost, the spring freshet, and the summer's growth, so as to maintain these arteries in a fit condition to act as water carriers. It may be as well to add that, if this were done, it would be necessary to make arrangements to secure effective irritation, and also a storage of water to provide for seasons of drought.

It may be said that this work would be both arduous and costly. Unquestionably; but, at present, the loss to the country through the desolating waters amounts, in one or the other of the ways I have mentioned, to hundreds of thousands of pounds annually.

The best plan would seem to be, that the farmers of a certain district should associate themselves together, employ such machinery, and such a number of hands, under skilled and experienced management, as would ensure the effectual carrying out of the work.

Doubtless, if this is really to be attempted, the landlords must assist. The farming interest is so heavily weighted, that it cannot pay even a moiety of the cost. The importance of the subject must be my excuse for bringing it, at this time, under the notice of members of our Society.

JAMES O. BEVAN, Assoc. Inst. C.E., &c.

72, Beaufort-road, Edgbaston, Birmingham,
February 19th, 1881.

GENERAL NOTES.

Telephones in India.—The Government Telegraphs Department in Calcutta obtained in November last, a sample supply of some thirty of the loud-speaking telephones of the Gower-Bell Company for experimental trials, and it is reported that the results have given so much satisfaction that the company has now received by telegraph an order for a large number of its instruments. If, says the *Engineer*, this may be taken in conjunction with the recently announced refusal of the Government of India to sanction the setting up of telephonic exchanges on the part of private speculators, it would seem to indicate a resolve on the part of the executive itself to supply the Indian public with what will soon be found to be an indispensable aid to the business and pleasure of life in India.

MEETINGS OF THE SOCIETY.

ADJOURNED MEETING.

Friday evening, at eight o'clock:—

FEBRUARY 25.—Discussion on Mr. Sedley Taylor's paper on "The Participation of Labour in the Profits of Enterprise." W. H. HALL will preside.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

MARCH 2.—"Lighthouse Characteristics." By Sir WILLIAM THOMSON, LL.D., F.R.S. F. J. BRAMWELL, F.R.S., Chairman of Council, will preside.

MARCH 9.—"Ascents of Chimborazo and Cotopaxi, in 1880." By EDWARD WHYMPER.

MARCH 16.—"The Compound Air-Engine." By Col. F. BEAUMONT, R.E.

MARCH 23.—"The Increasing Number of Deaths from Explosions, with an Examination of the Causes." By CORNELIUS WALFORD.

MARCH 30.—"Recent Advances in Electric Lighting." By W. H. PREECE.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

March 1.—"The Languages of Africa." By Robert N. Cust.

March 15.—"Diamond Fields of South Africa." By R. W. Murray.

April 5.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

March 24.—"The Future Development of Electrical Appliances." By Prof. John Perry.

The meeting previously announcd for April 7 will be held on May 12.

Indian Section.

Friday evenings, at eight o'clock:—

March 4.—"The Results of British Rule in India." By J. M. Maclean. Sir David Wedderburn, Bart., M.P., F.G.S., will preside.

March 25.—"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

Syllabus of the Course.

Lecture I.—March 7.

The production, regulation, and measurement of electric currents.

Lecture II.—March 14.

The laws of the mutual induction of currents and magnets. Efficiency of magneto- and dynamo-electric machines.

Lecture III.—March 21.

Use of magneto- and dynamo-electric machines for electric lighting. Heating effects of the current. Electric lighting by means of the arc.

Lecture IV.—March 28.

Subdivisions of the electric current. Incandescent lamps. Luminous effects of electric currents in a vacuum, and in various gases.

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Three Lectures.

April 25; May 2, 9.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

May 16, 23, 30.

MEETINGS FOR THE ENSUING WEEK.

Monday, Feb. 28th....Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Sir Richard Temple, "The Lake Region of Sikkim, on the Frontier of Tibet."
British Architects, 9, Conduit-street, W., 8 p.m. Discussion on "The Existing Law of Light and Air."
Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. G. R. Hardy, "The Mortality observed amongst the Various Classes of Bonus Policies in the British Empire Mutual Assurance Company."
Medical, 11, Chandos-street, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Mr. Justin McCarthy, M.P., "Ireland."

Tuesday, Mach 1st...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. Robert N. Cust, "The Languages of Africa."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. A. Schäfer, "The Blood." (Lecture VII.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on "The Weight and Limiting Dimensions of Girder Bridges," and time permitting, 2. Sir William Thomson, "Tide Gauge, Tidal Harmonic Analyser, and Tide Predicter."
Biblical Archæology, 9, Conduit-street, W., 8½ p.m. 1. Rev. A. Lowry, "A Few Notices in Ancient Jewish Writings on the Sagacity and Habits of Ants." 2. Prof. Eberhard Schrader, "Abydenus and the Book of Daniel."
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. F. Moore, "Descriptions of New Genera, and Species of Asiatic Nocturnal Lepidoptera." 2. Prof. J. O. Westwood, "Observations on Two Species of Indian Butterflies, *Papilio castor* and *P. pollux*." 3. Mr. R. Collett, "*Halichœrus gryphus* and its Breeding on the Fro Islands, off Trondhjem's Fiord, in Norway."

Wednesday, March 2nd...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Sir William Thomson, "Light-house Characteristics."
Entomological, 11, Chandos-street, W., 7 p.m.
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. 1. Mr. E. M. Holmes, "Vote on Jaferabad Aloes." 2. Mr. E. M. Holmes and W. Elborne, "Vote on some Drugs from Socotia."
Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. J. Romilly Allen, "The Saxon Cross at Winwick, Lancashire."
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

Thursday, March 3rd...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. S. G. Shattock, "Reparative Processes in Plants." 2. Prof. F. Jeffrey Bell, "The Apparent Retention of a Sur-anal Plate by a Young *Echinometra*." 3. Mr. C. B. Clarke, "Arnebia and Macrostomia." 4. Rev. R. Boog Watson, "Pleurotomidæ of *Challenger* Expedition."
Chemical, Burlington-house, W., 8 p.m. 1. Mr. F. Hatton, "The Action of Bacteria on Various Gases." 2. Dr. C. M. Tidy, "The Oxidation of Organic Matter in Running Water." 3. Dr. F. R. Japp and Mr. Edgar Wilcock, "The Action of Aldehydes on Phenanthrene-quinone in presence of Ammonia." (Second Notice.) 4. Dr. Japp and Mr. N. H. J. Miller, "The Action of Benzoic Acid on Napthaquinone." (Preliminary notice.)
London Institution, Finsbury-circus, E.C., 7 p.m. Rev. J. G. Wood, "The Inside of an Insect."
South London Photographic (at the House of the Society of Arts), 7½ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Rev. William Houghton, "The Picture Origins of the Cuneiform Characters." (Lecture I.)
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. J. B. Walton, "Steep Gradients versus Heavy Works"
Archæological Institute, 16, New Burlington-street, W., 4 p.m.

Friday, March 4th...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. M. Maclean, "The Results of British Rule in India."
Royal United Service Institution, Whitehall-yard, 3 p.m. Sir William Thomson, "His New Navigating Sounding Machine and Depth Gauge."
Royal Institution, Albemarle-street, W., 9 p.m. Sir William Thomson, "Elasticity viewed as possibly a mode of motion."
Geologists' Association, University College, W.C., 8 p.m. 1. Professor T. G. Bonney, "Remarks on proposed Classification of Rocks." 2. Professor T. G. Bonney, "A New Theory of the Formation of Basalt." 3. Mr. J. Slade, "Notes on the Microscopic Structure of the Basalt of Swallow Cliff and Uphill."
Philological, University College, W.C., 8 p.m. Mr. E. Brandreth, "Grammatical Genders."

Saturday, March 5th...Ladies' Sanitary Association (at the House of the Society of Arts), 5½ p.m. Dr. B. W. Richardson, "Domestic Sanitation or Health at Home." (Lecture IV.)
Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Stuart Poole, "Ancient Egypt in its ComparativeRelations." (Lecture III.)

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FRIDAY, MARCH 4, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

MR. WHYMPER'S PAPER ON CHIMBORAZO.

At the ordinary meeting, on Wednesday, 9th March, Mr. Edward Whymper will give an account of his recent ascents of Chimborazo and Cotopaxi. In order to accommodate the large number of members who have applied for tickets, this Meeting will be held, by permission of the Lords of the Committee of Council on Education, in the Lecture Theatre of the South Kensington Museum. Admission will be by the West Entrance to the Museum in Exhibition-road. It is hoped that this arrangement will be found convenient to the Members. Though every effort was made, it was found impossible to obtain a room of sufficient size near the Society's House.

The Meeting will commence at Eight o'clock. Doors open at Half-past Seven. About twenty Tickets still remain for distribution, and one each will be supplied to Members who apply before this number is exhausted.

No Person can be admitted without a Ticket.

By Order,

H. TRUEMAN WOOD,

Secretary.

STREET ACCIDENTS.

At the meeting of the Council on Monday, 28th February, an application from the Society for Preventing Street Accidents was considered, and the following gentlemen were appointed a Committee to meet a deputation from the Committee of that Society, viz. :—Sir Rutherford Alcock, K.C.B., Mr. G. C. T. Bartley, Mr. Andrew Cassels, Sir Henry Cole, K.C.B., Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E., with the Chairman of the Council (Mr. F. J. Bramwell, F.R.S.). The Committee of the Street Accidents Society appointed to confer with the members of Council are:—Lord Dorchester, Viscount Templetown, the Rev. W. Rogers, Mr. Brown, and Dr. Goodsall.

UNION OF INSTITUTIONS.

The following Institution has been received into the Union since the last announcement :—

North London High School for Boys, Castle-house, Mildmay-grove, N.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday, Feb. 24, 1881; Captain Sir GEORGE NARES, R.N., K.C.B., F.R.S., in the chair. The paper read was "Deep Sea Investigation, and the Apparatus employed in it," by J. J. Buchanan, F.R.S.E., F.R.S. This will be printed in the next number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

ADJOURNED ORDINARY MEETING.

Friday, February 25th, 1881; W. H. HALL in the chair.

The discussion on Mr. Sedley Taylor's paper on "The Participation of Labour in the Profits of Enterprise," adjourned from the 16th ult., was resumed.

Mr. George Shipton said he should like to refer in a few words to the remarks of the Chairman in reference to English trades unions. He understood him to say that, probably, we had not been able to see our way to such a means of reconciling the interests of employers and employed in this country as had been arrived at on the Continent, in consequence of the hostility of English trade societies. He was sure the Chairman would be the last knowingly to inflict such injustice on English trade societies, and he could assure him that members of the trades societies, instead of being hostile to any conciliatory offer, were always the first to make it. He could say a great deal on the other side, of men who had entered into negotiations and signed contracts that there should be no alteration of time or of wages without three or six months' notice, and he had known employers, in the face of an agreement like that, signed by both sides, scatter the whole thing to the winds without the least notice, and insist on a reduction of wages, and lock the men out if they refused. There was a case of the kind in Bristol at that very moment. However, he had no desire to use words which would increase any bitterness which might exist between employers and employed. They were met for a different purpose, that of endeavouring to recon-

cile the interests of both parties as far as possible. The subject had been somewhat departed from last week in the discussion, which touched on the question of good work and bad work, piece work and day work. This would form a very fitting subject for discussion by itself, but he would prefer pointing out what seemed to him defects in the various schemes brought forward by Mr. Taylor. To begin with, he took exception to one point, which, unless it were got over, would prevent English working men from taking an interest in the scheme, and that was to say that the participation should only take place in the profits to be created by the extra exertions of the men. He certainly thought that if workmen, by their own perseverance, skill, and care, made profits which the employer had not contributed to, those profits rightfully belonged to the men, and surely the employer would not be so immoral as to participate in profits which he had not been instrumental in creating. If the participation were only to come out of new profits, they had to thank the employer for nothing. He held it should be a participation in the general profits derived from the joint energies of those employed in the particular house, or calling. The next best scheme was very much after after the fashion of the plan adopted by Mr. Bord. He should advocate immediate cash payments of profits to workmen, and not a deferred advantage, though possibly there might be no reason why an agreement to defer the payments should not be made. It might be said that if the workmen suddenly enjoyed a degree of prosperity they were not used to, they would squander the money, but he had yet to learn that that did not apply to other classes as well. Why should a special moral restriction be applied to workmen, which was not applied to all classes? The Rev. Mr. Blackley had put forward a national scheme of insurance, which certainly had the merit of compelling all classes to contribute, without exception. What he objected to in Mr. Bord's plan was, that he wrote off 10 per cent. per annum on the capital invested, and then took half the profits remaining, the other half being divided proportionately amongst the workmen who had contributed towards those profits. He thought 10 per cent. was an excessive price to charge as interest upon capital sunk in a business, and that 5 per cent. was the maximum. If they wrote off 5 per cent., he held that all the profits derived from the joint energies of those engaged in the firm should be divided proportionately to their wages, amongst employers and workmen, giving to the employers their extra share as managers, and so on; but if they were going to make themselves so secure, first by having 10 per cent. on the capital, and then taking half the profits, there was very little left for the workmen. It seemed to be the idea that all these things must come from the workmen's side, and nothing from the employers. Otherwise, with this exception, Mr. Bord's plan was the best, inasmuch as there was an immediate payment of profits. The proposition of Mr. De Courcy was simply an utter piece of selfishness, and he should be sorry to see it applied in English industrial life. The persons employed in his office got no advantage until they had been in the firm 25 years, and then it was not paid to them at all, but invested in the house, or in Government funds, and practically the men received no direct advantage. He was one who did not approve of postponing every advantage from his labour until he was dead and gone; he liked to participate in them while he was alive. Mr. De Courcy's own language showed the scheme to be an utterly selfish one, because he referred particularly to its influence in making the *employés* work long hours in place of fresh hands being engaged. Now, if they only looked at the fact that in England there were a million of paupers to keep, and that one in ten of the population died a criminal or a pauper, it was absurd to put up as solution of the labour question a scheme like this. Their object should be rather to shorten the hours of labour, and why? As one instance, that workmen might come and take part in such discussions as the present. If English workmen were ever to hold their own it must be by lifting up their whole character, not by making them into a degraded and ignorant race. If they had not time, how could they improve themselves, in order that they might stamp on their own work their own character and their own conscience. He should therefore deprecate any system which would tend to physically deteriorate the workman, and shut out those from employment who were as much entitled to it as those who had already a position in the firm. Mr. Chaix's plan was too paternal. He would rather see a man entrusted with his own money, even if he made some mistakes at first, because it would lead the way to a better state of things hereafter, and the freedom he would have would be much more valuable than training him up in any way under the guise of paternal Government. English workmen would never be induced to go into any scheme of that kind, if payment were deferred. He could give a very striking instance of this. About 1878, Messrs. Wingate and Co., ship-builders, at Glasgow, had, in their establishment, an insurance and accidental fund, to which the workmen were compelled to subscribe. This was retained by the firm, and deposited in the name of the firm. Some time after they went into liquidation, seized on the money, and distributed it amongst the creditors as part of the assets, so that the workmen, although it had been deducted from their wages, lost every farthing of it. Any system which would hand over to the employers the profits to keep for the workmen would be highly unsatisfactory. If the sums were held in trust for them at all, it should be done by some responsible party, by some one agreed upon by both. As far as he had had time to study the plan of the late Mr. Leclaire, that was the best as a compromise, because there the workmen's counsels were brought in cooperation with the employer. The employer took his proper position as administrator of the firm, giving to it all the force of his individual character, but at the same time allowing his workpeople to participate in the whole profits. There was only one point which he should like to have cleared up. He believed they had to be employed for six months before they participated in the profits. Now, in times of brisk trade there were many workmen called in for three or four months, who contributed to the prosperity of the firm, and he could not see why they shoul dbe shut out from participating, to some reasonable extent, simply because they were unfortunate enough to be employed for only a short time. No more than 5 per cent. was allowed to the capital invested; the work was done in the ordinary working hours, and the extra profits, if any, were accumulated by the extra conscience and extra ability developed amongst the men, and not by working an excessive number of hours. The profits should extend to all workmen, and he hoped it was not intended that the system should be applicable solely through any "nigger-driving" system, or that the workmen were to work themselves almost to death in order to live, which would inevitably lead to physical deterioration. It should be simply by fair work that the profits should be realised. He thoroughly agreed with Mr. Taylor's position in the latter portion of his remarks. If there were any effort made of this kind, one thing was absolutely necessary, and that was, that the English employers should leave off their pride and arrogance, and no longer refuse to meet their workmen in council. At present, they drove to their shops in their carriages, and knew no more about their workmen than the Czar of Russia. They saw their foremen, agents, and managers, but with their workmen they never came in contact. They knew nothing of the vicissitudes of labour and did not care. Up to the present time that had been the bitter experience, but if there were a change, the workmen would be

only too glad to carry out such a scheme as that proposed.

Mr. William Botly could not quite agree with the opening remarks of Mr. Shipton. He rather understood that the 10 per cent. would be 5 per cent. on the capital employed in the business, and that the other 5 per cent. would be for the maintenance of the manager. As regards the importance of dividing a portion of the profits among the labourers, there should be a concensus of opinion, and he thought, on the general principle of the paper, they would be all agreed. In that Book which they all professed to be the rule of their lives, they were told not to muzzle the ox that trod out the corn, and that the labourer was worthy of his hire. Anyone at all acquainted with manufacture, agriculture, or commerce, found that it was the interest of the employer to do his duty to the workmen, by giving him a sufficient wage for his day's work, which should allow him to provide for old age. They should all do what they could to encourage thrift, and the principle now brought forward would, he thought, encourage that, and also the straightforward carefulness which they all desired to see in the working man. The paper had given proof of the beneficial effects of participation in profits in France; and notwithstanding some difference in the habits of the French and English, he did not see why the same system should not be adopted here. The remark that the result of labour, until it was ascertained, was an unknown quantity, was quite correct; but the labourer might be paid the regular wages in the district, and at the end of the year the profits could be very easily reckoned. That would be particularly applicable to agriculture. There were instances in England where that was done—as, for instance, on the property of the Speaker of the House of Commons. No doubt, there would be occasions—as, for instance, the year before last, which was the most unfortunate year ever remembered—when there would be no profits. One gentleman said the loss to the farming interest, on wheat alone, was five millions; but he believed it would be found the loss would be nearer 50 millions; and, of course, in that year the agricultural labourer would have had no division of profits at all. He hoped to see the time when, by better education and more thrift—which every one should encourage by their own example, whatever their position in life—the position of English workmen would be improved. No one ever rose to eminence without great application. This was shown in the case of George Moore, the Morrisons, and others. Some might say that workmen had not the power of doing so generally, but he said they had. He knew instances of persons who had raised themselves from common labourers to be small farmers; but then they made efforts which the generality did not do—they were not smokers or drinkers, but made the most of every trifle.

Mr. Quinlan said he did not come with the intention of speaking, but he thought he was bound to meet some of the remarks which were made by Mr. Shipton with regard to employers and workmen. He stated that the workmen were always anxious for arbitration, and to submit their case for equitable decision, and that the employers were not so. But look at the present state of affairs in Lancashire and Yorkshire. In these counties the colliers have struck for higher wages, which the employers say they cannot give; and they have offered, in proof of this, to lay their books before any competent accountant, and to submit the whole dispute to arbitration. According to the papers, that had been refused. He did not wish to say a word against workmen, but he protested against the entire class of employers and capitalists being stigmatised as tyrannical and unjust because some had been harsh. Mr. Shipton objected to more than five per cent. being allowed to the employer. But take the case of hazardous businesses, such as collieries, in which he was largely interested, and in one of which he was a director. They were liable to explosions and all sorts of accidents. Would any man who had money be satisfied to put it in these hazardous things for five per cent.? It would pay very well in some things. Three per cent. paid in Consols, but 20 per cent. would scarcely be a remunerative return in other occupations, such as mining, where the chances of loss of both capital and interest were very great. Mr. Shipton also stated that the whole of the profits should be divided amongst the workpeople; not that which they made by their own diligence or extra work. But would they divide the losses as well? It was necessary to face this question. They would only give five per cent. interest, and all the additional profits must be divided amongst the men; what about the losses. For various reasons he was in favour of a partial division of profits and superannuation. If a man went into an establishment, such, for instance, as Krupp's Iron Works, and he knew by the rules he would be entitled to superannuation by a certain time, it was a check on the natural tendency of a young man to change, and the consequence was, men would stop in such an establishment, with the result that they went on all through their lives at good wages, with plenty to eat and drink, and everything a man wanted, whereas, if they got the whole of their profits they would probably become rolling stones and ramble about, some would get to high positions, and others would go to the workhouse. He should prefer the middle course, giving the man a share every year of the extra profits, and putting by an equal amount, which he should be paid in case of accident or death. A case had been mentioned of the money put by being seized by creditors, and he believed something of the same sort took place with regard to a co-operative farm, which was carried on successfully for some time in Ireland, but all this could be guarded against if proper arrangements were made in the first place. Then it was said that new men ought to share with the old, but he could not see the justice of that. It was not the case anywhere, that he knew of, that a new man in an establishment got equal wages with an old one, except, perhaps, in a particular shop, where every man went in on the same footing, under special circumstances. He believed the participation plan was the best which could be adopted; and he thought the reason why some efforts of this kind had failed was, that the difficulties were not sufficiently appreciated and provided against. Some men would not care for the system, others, on the contrary, appreciated it. He could understand why Leclaire succeeded, by reading his life. He started as a workman, and gradually built up his establishment, and he could imagine him carefully selecting his men and his foremen; and when he commenced this participating scheme he was surrounded by a set of men whom he knew, and who knew him. The same principle would answer in this country, and it would help to put an end to piece-work, which, in the interest of all concerned, it would be well to get rid of, if possible. He did not see why the plan should not succeed, if it were carried out here with the intelligence which Frenchmen exhibited, but it should not be put in force without preparation. The men should be selected in the first place, and there should be means for getting rid of those whom it did not suit. He had always seen, that if you gave a man an interest in his work it would be done better, and more of it would be done.

Mr. George Howell said Leclaire's system did provide for dividing profits with the very newest comer into the firm, an instance of which was given in Mr. Hall's book or in Mr. Sedley Taylor's article, of a man who had worked one day of ten hours, when he received 6 francs and

50 centimes for his wages, and, at the end of the year, he had his proportion of profits just the same as the rest. He thought they had not yet realised the principles laid down in the paper, the central point being that the men contributed nothing in the shape of capital to the firm, but the whole of the capital was got out of profits. He was now using the term capital in the sense of money, not in the widest sense. The principle seemed to be this, that the men, not by working longer hours, but by working the ordinary day and being paid the current wages in the trade, having a chance of participating in the profit, threw an amount of intelligence, and skill, and energy into their work which had not previously existed. He did not think the workmen had anything at all to complain of in that respect. If they were paid the current wages, they realised that for which unions were primarily started, and if by extra energy and skill they could create more profits than the master originally obtained by the ordinary, perhaps slovenly and wasteful work, they were allowed to participate in those extra profits. That was only the first initiatory stage of the scheme, a stage which, to his mind, could be applied easily to almost the entire ramifications of industrial life in this country, and the workmen surely would have nothing to complain of if, after having been paid their just wages, they realised something in the way of profits, the higher the share, the better, of course; in Leclaire's establishment, it amounted to about 15 per cent. It ended in this—and the moral was the grandest part of it—that these workmen became better workmen than the ordinary workmen in the trade, and were not only paid the ordinary wages of the district, but could command higher wages, and were actually paid higher wages, and, in addition to that, still had the bonus. That was the earlier stage of the matter, but it was the other stages taken up by Leclaire which showed up the moral grandeur of the scheme, and he could not believe Englishmen were so far behind Frenchmen that the same could not be done here. He did not think Englishmen were more selfish than Frenchmen, though they might not be quite so free in their speculations. Leclaire's scheme was worked out under the great disadvantage of not being able to meet in public and discuss their plans, and thus lay down the basis upon which to work. The first starting-point seemed to have been his absolutely bringing in some bags of money and dividing the profits—not upon the year he had promised them, but upon the previous year, because the Government had refused permission to hold a meeting. The scheme which, perhaps, caused the greatest amount of discussion was the greater and broader one, in which the men became absolute co-partners—a scheme which, in a certain sense, had been applied in this country, and was still applied in some instances; but, in this particular case, not only were the men paid their full wages, and participated in a certain proportion of profits, but were entitled to all the benefits of the mutual aid society—in its first stage contributed to by the men and by the masters, but ultimately only contributed to by the profits—and the men participated in the first distribution of its funds when the society was dissolved. Subsequently to that, and in all later stages, the capital seemed absolutely to have been created out of the firm, a proportion of it having been set aside, in addition to the wages and the bonus, until the mutual aid society had sufficient funds, or nearly so (the balance being made up by Leclaire himself), to make it a sleeping partner in the concern. When the employers of England, or a large number of them, could once see their way to say to any number of men in their employment that they were prepared to make a similar step to that, his belief was that the workmen, whether unionist or non-unionist, as a rule would jump at it, but the difficulty was the one hinted at by the last speaker with regard to the losses that might be sustained in the course of business. Those losses were prudently prepared for by Leclaire, as they were by all other prudent employers. A man who made 20 per cent. this year, as a celebrated firm did which had been referred to in the course of the debate, and divided all the profits among the proprietors, and made no provision by a reserve fund, and then asked the men to help bear the loss when it came, was a very different thing to Leclaire's system. It was not enough to say whether the firm should reserve to themselves 5 per cent. or 10 per cent., seeing that the firm made the business and found the capital. No doubt 5 per cent. certain was beginning to be recognised as much better than a fluctuating per-centage, ranging from 10 per cent. or 20 per cent to *nil;* and when they could provide against these contingencies, it might be found that 5 per cent. would be sufficient. That was just the amount reserved by Leclaire for interest on capital in his business, that being given equally to the partners for their shares, and to the mutual aid society for its share, although its share of capital was made out of the profits. The question was, was there any insuperable difficulty on the part of English working men to entertain proposals of this kind, should they be made by their employers? He could not conceive for one moment that there was any objection to the scheme being tried anywhere, or that any well organised trade union would raise any objection to it. It was altogether outside the purview of the unions. He did not mean to say but that a well conducted firm of this description might incidentally interfere with the working of the union, because some of the societies had a very well elaborated scheme of mutual aid, in the shape of a sick fund, an out-of-work fund, and so on, such as was provided for in the mutual aid society of Leclaire, and that might be interfered with indirectly; but, if it were found that this could be done better in some other way, Englishmen would soon agree to the change. But suppose the scheme to go on in the most favourable manner, it would be a long time before it would be able to do away with great unions, like that of the engineers', which, perhaps, provided more for the sum paid in than any other benefit society. He could see many reasons why workmen should seek these advantages if employers were only willing to concede them, but it was lamentable to him to find that instead of the bonds of union between emyloyers and employed being made closer they were being continually loosened. They began that when they went from the month to the week in hiring, again from the week to the day, and again from the day to the hour, and the system existed now of mere minute contracts. How was it possible for any individual man to have an interest in the welfare and prosperity of a firm when he might be dismissed at a minute's notice? Anything which would give him a permanent and binding interest in the firm would help him in future life in more ways than the mere fact of getting regular wages, because it would have a great moral effect. He was, therefore, in favour of helping forward this movement as far as possible, by discussion and otherwise, until some employer of labour, having something like the generous sympathies of Leclaire, would be prepared to try it on a broad basis. With regard to the character of the business in which it was tried, he did not think that the house-painting and decorating business in Paris was quite of the precarious kind that it was in this country, and so far, Leclaire had an advantage; but it must be recollected that the painting and decorating firms in this country were not limited to those who were connected with jerry builders and field ranging, as it was called. There were great firms in London which kept their men on almost permanently, only discharging them under great and continued pressure. If the plan could be tried in that particular trade where a man had to take upon himself a certain amount of independent action, and yet must co-operate with the whole of his

fellows to produce a good result, it could be done in most trades. It was tried in this country to a greater extent than many supposed, especially on the system more particularly commented upon by Mr. Shipton — of deferred profits; but it sometimes became necessary to compel the owner of a share in the deferred profits to go out of the firm, and take his money with him. He did not know whether he was quite accurate, but he had heard, on good authority, of a man who had been for 24 or 25 years occupying a good position in a considerable firm, and who very early in life had participated in the profits to a certain extent, and also allowed a portion of his salary to accumulate. Ultimately, some alterations being made in the firm, it was suggested to him that he should retire from the business; he was willing to do so, though he did not like leaving, but said he should like to leave his money there. He was told, however, that they had as much as they knew what to do with, and, although it seemed an incredible sum, he was informed, on good authority, that the man was paid no less than £50,000 as his share. In Leclaire's establishment 15 per cent., on the average, was divided for nine years, and in addition to that the men had £21 each out of the mutual aid fund when it was shared. If they had gone on to a second share in that fund, it seemed probable that, in the course of the next 15 years, they would have shared from £50 to £60 each. He could only say that he hoped some employers in this country would see their way to bind their men to them by allowing them a participation in profits, and ultimately making them co-partners in the firm, because one example of that kind would do a great deal more to advance the matter than any amount of discussion.

Mr. Gridley said he had read Mr. Taylor's paper and the discussion on the previous occasion, although he was not present, and he was strongly of opinion that under certain conditions labour was entitled to much more than at present it generally received out of the profits of enterprise. He said this as an employer. Taken collectively, capital now stood as an absolute ruler of labour and exercise, a despotism of the most absolute character, but he was of opinion that such a system could not be much longer tolerated. These schemes were, he believed, honest endeavours to find a remedy and to get for labour more justice, and he should willingly assist in the proposed society for making the idea better known. It would be much more difficult, however, in England than in France, because the French were much more suited to co-operation; the English were slow to believe in any idea until it was shown to be an advantage, whilst the French were eager to try any new scheme of equality and fraternity. With respect to the conditions under which participation could and should be attempted, any endeavour to try it where the employer did not primarily consider that he had certain moral duties owing to labour, would soon, he feared, end in failure. Dr. Ingram read a paper at the last Trades Union Congress, in which he dealt with the position of capitalists, and pointed out that they ought to regard themselves as discharging a public function, namely, that of conservators and administrators of human capital. Unless capitalists recognised these moral duties, and obtained the respect, esteem, and trust of their workmen, he could see nothing but failure. Carlyle said that cash never yet paid one man fully his deserts to another, and never would. You might commence participation in a concern by appealing to the greed and selfishness of the *employés*, and in that way get them to work better and amass money, and assist capitalists to do the same, and this was pretty well as far as Mr. Taylor wished the matter to be carried, but in his opinion this was a most objectionable way of gaining a position of prosperity, even if that could be thus attained. They must appeal to the great moral power in man, not to his selfishness and greed. A true workman did not work honestly and thoroughly because he was paid to do it, but because he felt to do the contrary was despicable and dishonest.

Mr. Pfoundes thought they were overlooking the fact that a great deal had already been done in past years in the direction pointed out by the paper in foreign countries. Twenty-four or twenty-five years ago, efforts were made in this direction in the Australian Colonies, and he wished to point out the necessity of turning attention to what our own countrymen had done, when released from the trammels so much complained of, which hampered them at home. There were thousands of the most intelligent of our countrymen living in the colonies and foreign countries, who were actually now competing under most favourable circumstances with those at home, and the time had come when a question like this should be taken up on a broader basis, so that, admirable as the paper was, he submitted it was not altogether what was required. If they could go abroad and see how their own countrymen succeeded there, they might learn some very valuable lessons. The improvement had to come from the men themselves. He had seen Englishmen, landing in Melbourne, laughed and jeered at as new chums by their own countrymen, who had only been two or three years in the colony; and in the same way in Castle Garden, New York, he had seen them laughed at as gawkies, by those who had only been in that country a year or two. He had seen the same class in the New English States, and in the colonies, showing a wonderful improvement in two or three years; and since his recent return to this country, he had seen the necessity of something more than the merely half-hearted measures which were continually suggested, being brought forward. He did not think it was practicable, in a business point of view, to entirely adopt principles which might, more or less, succeed in foreign countries like France; but an entirely reformed social system would be needed; and that reform must come from below as well as above. While there were these conflicts going on between workmen and employers, and they were constantly quarrelling over the shell, other nations were stepping in, and taking the oyster out. Our commerce was falling from our hands, simply from the quarrels of labourers and capitalists. How could they expect a division of the profit which must, in great measure, result from clever, hard-headed men, when they were obliged to go on the market, and speculate in raw material, to keep their hands employed. When he was abroad, some of their own correspondents had sent out goods which were sold at a loss; but they were manufactured simply to keep the mills going. How were profits to be divided in such cases? Would the men stand having a per-centage taken off their paltry wages, in case the head of the firm made a mistake on the market?

The Chairman said there was no intention of taking anything off anyone's wages, the proposal was to add something to them.

Mr. Pfoundes said what he wanted to point out was the necessity of looking to what our countrymen were doing abroad.

Mr. Phillips said his impression was that no system except that of Leclaire was worthy of consideration, because all the others were simply the development of selfishness. They sprang from selfishness in the employer, were calculated to develop selfishness in the workmen, and on the whole, would tend to demoralisation. Leclaire's principle was very simple, and would be immediately applicable not to one occupation only, but wherever people were employed; the only requisite

was to find the employers with an inborn spirit of justice sufficient to induce them to put it in practice. Once you had the principle, others would soon follow and co-operate. The public, who were much interested in the kind of goods they purchased, could assist by giving such establishments their support. Sometimes there was a confusion made between the capitalist and employer. You sometimes heard rich men called captains of industry, but many of them were not captains of industry at all; they were simply owners of capital, who farmed the industry and intelligence of other men. They took six portions out of ten, and gave the workman only four to live upon, while they grew rich on the six parts they had taken. That was the general rule, and it was supported by the principles of the dismal science. To these men it did not matter whether the wages given to the workmen were sufficient to keep body and soul together or not; if they could get a man willing to accept such wages they felt justified in giving them. But that was not a fair portion. If that system continued to prevail, the labouring people throughout the world who now spoke with one sentiment, but different languages, would eventually have those sentiments conveyed in one language, and when they did so speak, it would be with a solidarity that would have power to act. And how would it act? That lay with the capitalists and employers who regulated the legislation of the country. If they sowed wisely they would reap well, but if they sowed the miserable system which now existed, the time would come when they would reap ill. Various points had been raised which hardly bore on the question. With regard to the interest which should accrue to the invested capital, a statement was made with regard to mines, that the capitalist who invested in a mine suffered from explosion and accidents. He always thought the boot was on the other leg. It was not the capitalist who suffered, but the men. If 15 per cent. was a fair per cent. for the capitalist to receive who invested his money, what was a fair percentage for the man who invested his life? Much stress had been laid on the participation of profits *versus* participation of loss, but he believed the workman was just as fair and intelligent as the capitalist, and if you gave the workman a fair share of the profits, he would be quite willing to take his fair share of the loss. He would not deal with many of the side issues which had been raised, but with regard to piece-work and waste of material, he might say that he had frequently had charge of work, and while in that position had an opportunity of seeing how it was done, and how material was used. He had seldom cause to find fault with men working day-work, but he had noticed the greatest waste of material he had ever come across had been indulged in by piece-workers. You might get the most physical exertion out of a man who worked piece-work, but you would not get the best work. If he (Mr. Phillips) was going to sea, and had the choice of going in a ship which was built by piece-work, or one that was built by day-work, he would much prefer the latter.

Mr. Hodgson Pratt said he hoped that, if any practical result were to follow this discussion, the form participation would take would not be that of giving a few small sums in the shape of bonus at the end of the year, which would be a very small step in the desired direction, but that the main object steadily kept in view would be the permanent identification of interest between the workmen and employers in the same house. That would not be realised by simply giving a bonus at the end of six or 12 months. The great object should be to make the workmen gradually more and more partners in every concern in which they were employed. What was wanted was to do away with the sharp line of division between the two classes, and to make every workman a capitalist as well as a mere wage-receiver. It was quite clear, from the experiments of Leclaire and others, that not only increased industry, attention, and desire to prevent waste would be the result, but that, in every form, the identification of interests on the part of all employed must bring to the firm new ideas and suggestions as regards processes, and so forth, which could not fail to be beneficial. It had been pointed out over and over again that many of our industries were in a very precarious position at the present time, and that, in many departments, we were beaten by foreign competition. All this tended to show that England was now undergoing a considerable crisis, and that her future depended on her undergoing an industrial change, which should enlist a greater amount of intelligence in her manufactures. Compare the present condition of things, in which the workman could have little or no interest in the firm, with that which would take place if every workman in every large firm had an opportunity of being an holder of its capital. In that case all men of intelligence would be constantly thinking how to increase the profits, and make the concern more successful. A vast number of minds all over the country would be electrified, so to speak, by that desire, and the new ideas would be forthcoming, which were absolutely necessary to enable us to compete successfully with other countries. One word with regard to Messrs. Briggs' collieries, which had been alluded to. All the facts connected with that went to show that there was a fatal error on the part of those employers. They did not approach the workman as an associate, but simply as a workman, to receive what they chose to give him, and with such a state of things there could never be that complete confidence on both sides which was essential to realise the welfare of the undertaking. That Messrs. Briggs could have supposed for a moment that the workmen in their employ would consent to cut themselves off from their trade association, showed, in the most striking manner, how completely faulty was the spirit in which they approached the experiment. There must be perfect equality of rights and feeling between the two parties. Messrs. Briggs showed themselves wholly unable to understand the problem before them, when they ventured to trench on the ordinary independence and self-respect of their workmen, by dictating to them what they should do in connection with their trade society. If employers wished this movement to succeed, they must approach the matter in an altogether different spirit; treat their workmen with confidence and respect, and make them sharers in the capital.

Mr. Sedley Taylor said he would reply very briefly to the main objections which had been advanced against the principle of participation during the discussion. Mr. Wolstencroft had expressed an opinion that, in some industries, piece-work would be found superior to participation. There were, however, theoretical considerations of much force which made for the latter, as against the former, system. Participation stimulated excellence of work in every direction, whereas piece-work, though it increased quantity of production in a given time, had no tendency whatever to improve quality or enhance economy beyond the degree which would just pass muster with the inspecting examiner. But theoretical considerations were not all they had to judge by. They had the evidence of the important firm, Billon et Isaac, at Geneva, where the managing director and a large majority of the workmen had stated, as their deliberate opinion, that piece-work was no effective substitute for participation in profits. The two systems were, however, capable of being worked together without the slightest difficulty, as was, in fact, done in the establishment just referred to, and in many other participating houses on the Continent. The same speaker had denied the applicability of participation to coal-mining, on the ground that the colliers were paid only for the coal actually brought to the surface in proper condition. He (Mr. Taylor) had,

however, been informed, during a recent visit to the Newcastle coal-field, that a great preventible waste of materials occurred in that industry, which payment by results did not diminish in the slightest degree, but which participation would directly tend to check. He had learned that large quantities of the timber used for shoring up the workings were constantly getting buried under the *débris* thrown out in the hewing process, and permanently lost. The pitmen had no interest in preventing this waste, and, rather than make their employers a present of the labour required to remove the timber to a position of safety, rarely hesitated to entomb it, for good and all, under the unsaleable small coal thrown aside in the operation of hewing. Payment by results thus actually tended to encourage this waste, whereas participation in profits would teach the miners to suppress it as directly injurious to themselves. In reference to the very satisfactory statement which had been made by Mr. Lloyd Jones that there was no reason to apprehend hostility on the part of trades union leaders against a movement for industrial participation, a very important letter had reached him (Mr. Taylor) from Mr. Burt, M.P. for Morpeth, whose connection with the miners' union was well known. "I am glad" wrote Mr. Burt, "that you are carrying on your efforts in favour of co-partnership, or, as you well express it, participation by the labourer in the profits. I quite agree with your views, and wish you every success." A movement which had the support of Mr. Burt in the North, and of Mr. Lloyd Jones and Mr. Howell in the South, had no reason to anticipate an excommunication by trades unions. Mr. Trewby had objected to Leclaire's system that it afforded no outlet for individual enterprise, as, if a man started in business on his own account, he would lose whatever he had deposited in the concern. As far as promotion to higher employment in the house itself was concerned, the Maison Leclaire offered to unendowed talent and perseverance most exceptional "outlets." The posts of foremen, and even those of the two managing partners, were open to, and obtainable solely by, merit. MM. Redouly and Marquot, the present heads of the house, had both begun work as simple apprentices, and owed their present honourable and lucrative positions exclusively to their own abilities and high principle. In quitting employment by the house for a private enterprise, a member of the mutual aid society would doubtless lose his right to a retiring pension, but he would carry with him the result of cash payments, averaging 15 per cent. on each year of his work for the house, which it would be his own fault if he had not systematically capitalised. Mr. Trewby's objection was, undoubtedly, of much greater force against M. de Courcy's system of long-deferred participation; it should, however, be borne in mind that that system had in view the case, not of workmen, but of clerks, who could only under very exceptional circumstances hope to become employers of labour themselves, and whose ambition was, as a rule, limited to the attainment of confidential posts immediately below those occupied by the capitalists at the head of the concern. For men thus situated, a permanent connexion with one and the same house was a distinct advantage, and the tie involved in M. de Courcy's system would, therefore, be far less irksomely felt by them than by workmen whose circumstances involved frequent changes of employer. To Mr Shipton's view, that the entire surplus profits should be allotted to the workmen whose more effective labour called them into existence, he would reply that some material advantage must be offered to the employer, in return for the time and trouble which he would have to expend in organising and superintending new industrial relations. Much thought and energy would be required in making the change and insuring its success, and employers could not fairly be called upon to make such efforts, unless on behalf of a system of mutual advantage. Mr. Shipton's proposal to limit the interest on capital invested in production to 5 per cent., without making any allowance for the great differences of trade risk inherent in different industries, could not possibly be entertained. The same speaker's apprehensions that participation would lead to "nigger driving," and premature exhaustion of the labourer by an increase in the hours of daily work, lacked all support from the experience of participating houses, where the hours were no longer, nor the work more physically exhausting, than in concerns carried on in the ordinary way. It was by united and heartier work, not by intensified physical exertion, that the happy results of participation were to be achieved. In order to show, on the authority of a well-known political economist, that participation in profits approached the problem of capital and labour from the only point of view which offered any prospect of a solution, he would quote the following passage from Mr. Fawcett's work on "Pauperism"*:—"It is vain to expect any marked improvement in the general economic condition of the country, as long as the production of wealth involves a keen conflict of opposing pecuniary interests. The force which ten men can exert may be completely neutralised, if they are so arranged as to contend against, instead of assisting, each other. Similarly, the efficiency of capital and labour must be most seriously impaired, when, instead of representing two agents assisting each other to secure a common object, they spend a considerable portion of their strength in an internecine contest. All experience shows that there can be no hope of introducing more harmonious relations, unless employers and employed are both made to feel that they have an immediate and direct interest in the success of the work in which they are engaged." He was personally authorised to say that the Postmaster-General was prepared to repeat, with even accentuated emphasis, the strongly favourable opinion on industrial participation expressed in the volume just referred to. Mr. Taylor concluded by again urging the advisability of forming a society to promote the practical study of participation, and by renewing his request that conditional adhesions to such a society might be forwarded to him at Trinity College, Cambridge.

The Chairman said he must add one word of explanation of the remark which fell from him on the opening night with regard to trades unions. He merely threw out the suggestion that trades unions might be one of the possible obstacles to the spread of this scheme. He did not make any assertion on the subject, but he was aware that unions did not exist in France, where these participation schemes flourished. He was still bound to think to a certain extent that the trades union organisation, on the part of the men or of the masters, did present certain obstacles to that familiar intercourse between individual master and man which was so desirable, but he could hardly regret having thrown out the remark, because it had elicited such emphatic repudiation of antagonism to the principle of participation on the part of leading unionists. He could not believe that in England—where capitalists were known to bestow £100,000 on founding a library or giving a park to the people, as some men did in the North of England, thus devoting almost the whole of their accumulation in gifts to the place where their wealth was made—that men actuated by the spirit of Leclaire would not be forthcoming. He thought that when such an experiment were set before them, men of the stamp of Hugh Mason and Firth would feel infinitely more satisfaction in spreading their munificence over their whole lives, than in deferring it to the end, and then pouring it forth in this generous and wholesale fashion. In conclusion, he proposed a vote

* London: Macmillan. 1871. P. 164.

of thanks to Mr. Sedley Taylor, and endorsed his desire for the foundation of a society to disseminate information on the subject of participation in profits. At these discussions there had been a more marked attendance of gentlemen representing the working class than the employers, and in order to carry on the subject, he hoped that at the next meeting they might secure the attendance of several large employers of labour.

Mr. George Shipton seconded the vote of thanks.

Mr. Crace, jun., said, as an employer, he begged to add his voice to the vote of thanks, as he felt very much indebted to Mr. Taylor for bringing the subject forward.

The vote of thanks was carried unanimously.

FOREIGN AND COLONIAL SECTION.

Tuesday, March 1st, 1881; Sir Henry Barkly, K.C.B., F.R.S., in the chair.

The paper read was on—

THE LANGUAGES OF AFRICA.

By Robert N. Cust,

Honorary Secretary to the Royal Asiatic Society.

It may be asked why the subject of language is brought forward in a Society whose primary object is the illustration or advancement of Arts, Manufactures, and Commerce. The reply is, that language has a very intimate connection with the development of these agencies, and the disclosures made in the course of the study of a language, throw a light upon the social and intellectual characteristics of the people who use it. Language is indeed a Science, but the method of conveying sounds to writing by symbols is an Art, and one of the most ancient, continuous, and interesting. The presence or absence of certain words in a language have a historical value. How shall we account for the Monbutto, on the River Welle, using the word "tobboo" for tobacco? After all, the commerce of thought is the greatest and oldest form of commerce that the world can have known, and no manufacture is older or more widespread, or more ingenious, or representing more clearly the line betwixt man and the lower order of creation than the manufacture of words, which has been going on without cessation ever since the world began.

I do not presume to claim a personal knowledge of any one of the hundred languages of Africa which pass under review, except Arabic, which is an imported alien. My statements rest not upon individual speculations, but upon the practical collection of facts by one class of scholars in the field, classified and arranged by one or two great comparative philologists in the cabinet, and thus presented to the notice of anyone who has the taste to study the subject. Every statement must rest "upon authority," and it is always better to give at once the name of the authority. I have followed not blindly, but with deference, one of the greatest living comparative linguists, Dr. Frederick Müller, of Vienna, who has given us his views in three famous works, "Reise der Novára," "Ethnologie Algemeine," and "Grundriss der Sprachwissenchaft," only a portion of which last has as yet appeared. In these volumes, the whole of Africa is embraced, and a provisional classification suggested, but certain portions of the field are occupied by three other distinguished German scholars, the late Dr. Bleek, in South Africa; Dr. Koelle, in West Africa; and Professor Lepsius, in North-East Africa, and a great diversity of opinion is found to exist upon many points. Scores of learned English, French, German, and American scholars have handled different portions of the subject, and contributed good, sound bricks to the great edifice. Some attempts has been made to popularise this knowledge in England, by Mr. Stanford, in his "Compendium of Geography and Travel," and by Hovelacque, in his "Linguistique," but in both volumes all that is reliable has been derived from Dr. Frederick Müller, in the one case acknowledged; in the other, this acknowledgment has been forgotten, and consequently the value of the communication is much diminished.

It is as well to state in advance, that our knowledge is still most imperfect. It cannot be said, with regard to any of the sub-divisions of the subject, that we have, at our disposal, the material available for forming a definite opinion. Each traveller has brought home the names of new tribes, speaking separate languages. In some cases a scanty vocabulary represents all that we know of the words, and a doubtful entry in a map is all that we know of the habitat. Now, the two elementary requisites for linguistic knowledge of the lowest order are a language-map, showing distinctly the habitat of the people, and a vocabulary of some extent, showing distinctly the words which they use, taken down on the spot, or from the lips of individuals to whom the language is their own proper tongue in habitual and actual use. We have very much the same knowledge of the languages of Africa, that a geologist has of the surface of the globe, *i.e.*, a tolerably accurate acquaintance with the languages spoken on the coast all round the Continent, with an occasional peep into the interior, and a visionary speculation on the subject of the centre.

The ancient nations of Europe and Asia have left records of their languages, as spoken in old times, in literature or monumental inscriptions. With the exception of Egypt, Abyssinia, the Punic of Carthage, and the Tamâseq of Libya, Africa has no record of the past. The seed-plot of all the existing alphabets of the world is found in the hieroglyphics of Egypt, but no native of Africa has devised a practical form of writing: the syllabary of the Vei on the West Coast is merely an ingenious adaptation of an old idea to new symbols, and not an original invention. In considering the languages of Africa, we have no means of comparing the past with the present; our task is limited to recording what we find spoken by the people, and to reducing this record to such a form of classification as is possible. A century hence some form or other of the Roman alphabet will be the written character of nearly the whole of Africa, being adopted by the missionaries and European settlers, east, west, and south. The Arabic character will be retained for Arabic, and such of the vernaculars as are used by half-bred Mahometans; the Abyssinian and Libyan form of script, even if they survive in their own localities, will never be propagated beyond.

I accept the classification of Frederick Müller as the best that is possible to devise in the present state of our knowledge; it admits of unlimited ex-

pansion as regards the Bántu family; it is exhaustive as regards the Semitic and Hottentot; and approximately so as regards the Hamitic. The Nuba-Fulah is a sub-division, still most imperfectly understood; and the Negro sub-division is merely a bag, in which unclassified languages are roughly thrown, something analogous to the Turanian and Allophyllian of the linguistic scholars of a quarter of a century ago, without any pretence to mutual affiliation or connection. Over and above the names recorded by travellers or word-collectors, is a great multitude (which no man can as yet number) of people and tongues, which it must be left to future generations to discover and record; and, till that event takes place, no one can presume to say that his account of the languages is complete. And there is this further complication, that writers constantly record the fact, that such and such a language is dying out, and, as this process has been going on for centuries, leaving not the faintest impress on the sands of time, an idea may be formed how remote is the solution of the problem of the origin of human speech.

It would be impossible in the brief time allotted to me to do more than give a most summary account of the different groups and languages, indicating, as I go on, the approximate localities in which they are spoken. The opportunities afforded to me have been most exceptional. The great propagandists of linguistic knowledge all over Asia, Africa, America, and Australia, have been the great Protestant Missionary Societies, and foremost among them the British and Foreign Bible Society. The motives of the linguistic labours of this last society is a higher one than the promotion of science, but it has, by its co-operation with the other societies, brought together a *repertoire* of languages and dialects in the form of translations of the Scriptures, the like of which the world never saw, and which is the wonder of foreign nations; and this remark specially applies to Africa. No other motive is conceivable to induce men of scholarship and industry to run the risk of disease and death for the purpose of reducing to writing the form of speech of downright savages, except for the one purpose of religious instruction. In many languages the Scriptures are the only book, and a linguistic scholar would be devoid of all feelings of gratitude, if he did not heartily thank the missionary for opening out to him channels of information, hopelessly concealed, and the Bible Society for scattering it broadcast at far below cost of the mere printing.

The languages of Africa are provisionally grouped with the following sub-divisions. I use the word "family" where a distinct linguistic connection is admitted; in other cases, the word "group":—

I. Semitic.
II. Hamitic.
III. Nuba-Fulah.
IV. Negro (proper).
V. Bántu.
VI. Hottentot and Bushman.

We must consider each separately.

I. The Semitic family (for it is a family in the strictest sense of the word) is well known. It resembles the Indo-European in being inflexive, but its method of inflexion is quite peculiar; it is most beautiful and symmetrical, but no explanation has ever been given of its origin. We find it in full development in its earliest records. The Book of Genesis gives an account of the creation of the world, but the words used for that account indicate a language in a very high state of development, and this characteristic is sharply brought out by contrasting the refined mechanism of the speech used by Moses with contemporary Egyptian records. The influence of the Semitic on the Hamitic group, or *vice versâ*, as some assert, is of the slightest. The Semitic nation were at all times alien in Africa, but it received from Egypt the precious gift of alphabetic writing, which it handed on to the rest of the world, as if it were of its own proper invention. There are two branches of the Semitic family, that of the North Coast of Africa, and of Abyssinia.

The Semites possessed the eastern flank of the Nile valley from a remote period. The notorious subjugation of Egypt by the Hyksos, and the descent of the Hebrews into Egypt, have left no linguistic traces in Africa; but the colonisation of Carthage from Phœnicia has left its indelible trace in monumental inscriptions, in spite of the attempt of the Romans to destroy all trace of the foreign culture of their defeated rival. Centuries later, the Arabians conquered the whole northern coast of Africa, beyond even the pillars of Hercules, and Arabic supplanted the old Egyptian language in the Nile valley, and pushing aside, if not destroying, the Hamitic languages of Numidia and Mauretania, became the dominant languages of Tripoli, Tunis, Algeria, and Morocco, with a distinct dialectic variation from the pure form of the Arabian desert, and the Korán. A third Semitic invasion of Africa took place from South Arabia across the Red Sea, and is known as the Ethiopian or Geez, the language of Abyssinia. In course of time the ancient form of speech gave way to the modern Tigre, and the cognate Amháric. These are spoken by a Christian population in a retrogade state of culture. Travellers have brought to notice two other distinct Semitic languages, the Harári and Saho, on the flanks of Abyssinia, but of no importance.

The influence of the Arabic extends far beyond the limits of the settled populations of particular kingdoms. It is the vehicle of thought over the greater part of Africa, either in the mouths of the Bedouin Nomads, who surprise the travellers by their unexpected appearance, or of invading conquerors, such as the Sultan of Zanzibar; of enterprising merchants, such as the slave dealers, who are generally half-bred Arabs; of dominant races, such as that of Waday, in Central Africa; and lastly, it is the instrument of the spread of Mahometanism, and of whatever culture existed independent of European contact. Up to this time it has had entirely its own way, both as a religious and secular power, but it may be presumed, that its progress will now be checked by the powerful intrusion of the English, French, and Dutch languages, and the resuscitation and culture of the numerous, strong vernaculars, which are ready to the hand of the European civiliser and instructor. The Arabs have left names in their language, Kabail, Kafir, and Swahéli, which can never be forgotten.

II. The Hamitic languages come next in order;

they are presumed to be aliens from Asia, but at so remote a period, that the tradition fails. It may be bold in the present state of our knowledge to call this sub-division a family, it will be safer to style it a "group," with marked resemblances. It may be sub-divided into three sub-groups—(1) Egyptian; (2) Libyan; (3) Ethiopian. They probably have linguistic relations to each other, but they have not as yet been worked out, so as to win universal concurrence, in the sense that the inter-relation of the Semitic language is admitted, as a fact of science. All the languages of the first sub-group have passed away from the lips of men; the Coptic died some centuries ago, and has a galvanised existence as the vehicle of religious ritual; the Egyptian died before the Christian era, and as the tradition of its interpretation died also, it became linguistically extinct, or unintelligible, until revived by the genius of scholars of this century. As records carved on stone exist in this language, fully developed both as to its grammar and triple mode of writing, as far back as 4,000 years before the Christian era, no nation in the world, and no family of languages, can compete with Egypt and the Egyptian on the score of antiquity. Moreover, in the handling of words and grouping of sentences, we become aware that we are dealing with an instrument of thought indefinitely more ancient than the most ancient of Semitic or Arian records. Egyptian had its day, and under Greco-Christian influences passed into Coptic, which again disappeared before the inroad of Arabic, thus supplying one of the most notable instances of a nation changing its language, as few will doubt, that the Fellah of Egypt is the lineal descendant of the Egyptians as depicted in the monuments.

To the west of Egypt, along the coast of the Mediterranean, stretches that vast country known to the ancients as Libya. Herodotus, the father of history, knew about the Libyan tribes, as Greek and Phœnician colonies were settled on the coast. This region was known to the Romans as Mauretania Numidia, and Getulia. The Aborigines outlived the Phœnicians, Greek, Romans, and Vandals, and still struggle against the Arabs, Turks, and French. The old Libyan language had no literature; it is dead, and is only faintly guessed at by inscriptions. The region is now known as Tripoli, Tunis, Algeria, Morocco, and the great Sahára. In one sense, the name "Berber" may include all the Hamitic forms of speech of this sub-group, but other terms are met with, either dialects, or separate languages, Kabyle in Algeria, Shilwa in Morocco, Tamáseq in the Oasis of the Sahára, Zanàga on the frontier of Senegal. The extinct language of the Canary Islands, the Guancho, belonged to this group. The French have contributed a great deal to the knowledge of this branch of the Hamitic group, in which there is an entire absence of culture, and the majority of the population is nomadic and savage.

The Ethiopian sub-group of the Hamitic group lies along the Red Sea, intermixed geographically with the Abyssinian branch of the Semitic family already described. The languages are:—The Somáli, Galla, Beja or Bishári, Fulásha, Dankáli, and Agau. The Victoria Nyanza occupies a remarkable ethnical and linguistic position. It is here that the Bántu, Negro, Nuba-Fulah, and Hamitic groups impinge on each other. Mtesa, King of Uganda, is credited with being of Galla origin, ruling over Bántu subjects. Our knowledge of the tribes to the north of Victoria Nyanza is too imperfect to arrive at any certain conclusions. No Semitic influences have been as yet felt in the culture, religion, or language of these races. They are entirely uncivilised, without culture, generally pagan, nomadic, and savage.

III. We pass to the third group, the Nuba-Fulah, the least well-known, and the most doubtful classification. Up to this time we have dealt with inflexive languages; all that remains in Africa is agglutinative. Ethnologically speaking, the Semitic, Hamitic, and Nuba-Fulah belong to "lank curly-haired" races. All that remains of Africa consists of "woolly-fleecy, or woolly-tufted haired" races. It does not follow that the linguistic fissures should be the same as the ethnic, and we know that the contrary often prevails. Frederick Müller lays it down that this group, whose habitat is partly in the midst of the Negro group, and partly on their northern frontier, is distinctly separate from the Negro, both by physical appearance, and other certain ethnical details. It occupies a position midway betwixt the Hamitic and Negro; and here let it be borne in mind, that the Bántu family is supposed to occupy the same intermediate position; but the Bántu, both in their physical and physiological characteristics, take after their Negro pregenitors, while the Nuba-Fulah approximate more to the Hamitic. The connection between the Nuba and Fulah seems by no means certain. Let us consider each separately.

The Fulah family is found on the West Coast. The word means "yellow." The Fulah considers himself greatly superior to the Negro, and claims a place among "white men." He is found living intermixed with the Negro from the Lower Senegal in the west, Darfúr in the east, and from Timbuktu and Haussa in the west to Yoruba in the south. He first made his appearance as a plundering intruder, and he is a Mahometan. In the kingdoms of Sokotu and Gandu there is a Fulah power. The name appears as Pul, Pulo, Fulah, Fulbe, Fellata, Fuladu. The Fulah race has intermixed with the Negro, which has produced other varieties. Fortunately, we have an excellent grammar by Reichardt, and a translation of some chapters of the Bible by Consul Baikie. Seven varieties of languages, or dialects (for it is impossible to say which) are recorded; but Futa jallo, on the River Senegal, is accepted as the standard. Its linguistic features are, the use of affixes, and the existence of genders, rational and irrational. The languages may be accepted as belonging to one family, and all going back to the same mother-speech.

The Nuba sub-group reach from the field of the Fulah family eastward, to the field of the Ethiopian sub-group of the Hamitic group. The pure Nubians now inhabit the valley of the Nile, from the first to the second cataract. They call themselves Barabra, and are Mahometan. Schweinfurth's narrative shows that they are a dominant race, superior in power and culture to the lower Pagan races of their group, into whose territory they make inroads as merchants and slave-catchers. It is remarkable that the Nubians must have moved into their present habitat in historical times, as

Herodotus does not mention them, and could not have overlooked them, had they been there. The name Νοῦβαι first appears in Eratosthenes, who wrote, in the latter half of the third century B.C., of them as a great people, not subject to the Ethiopians of Meroe; they must have in the interval immigrated from the West. We read of later immigrations of the same race in the time of Diocletian, 300 A.D. The name of other languages, or dialects, closely connected with Nubian, are given; these races are wholly without culture and literature, and imperfectly known, and dwell in the Nile valley. With far less certainty the Shangalla, on the river Takázi and Atbara, known to us by the reports of the Roman Catholic priest, Beltráme, and the Wakuavi and Masai, who are made known to us by the Protestant missionaries at Mombása, are included in the Nuba sub-group. Still more hazardous, and dependent upon the collection of future material, is the assignment to this sub-group of the numerous tribes, whose existence has been revealed to us by Schweinfurth and Junker, on the watershed of the basins of the Nile and the Welle. Unfortunately a fire destroyed all Schweinfurth's linguistic collections. They are the Monbuttu, the Nyam-nyam, the Krej, and the Golo. It must be left to the next generation to decide with certainty concerning the language of these tribes. Before leaving the group of Nuba-Fulah, it may be mentioned that it is classed ethnologically with the Dravidian and Kolarian families of India.

IV. The Negro group is the next. As stated above, it is a mere bag, into which all the languages spoken by woolly, fleecy-haired races have been flung. As far as we know, they are all agglutinative, but that is but a slight link of connection; the Negro group by no means extends all over Africa, but it comprises the great bulk of the population. A race with less inherent vitality would have been extinguished by the trials which it has had to undergo, circumscribed to the south and east of the Bántu, pressed upon to the north by the Nuba-Fulah, and deported in millions by the Europeans. The Negro may be said to share with the Bushman the honour of being the original inhabitant of Africa. The tract from the River Senegal to the River Niger is the seat of the pure Negro, but the return from America, or from captured vessels, of freed Negroes of very mixed races has affected this purity, and some of the mixed races, containing Hamitic, Semitic, and Fulal elements, are the finest.

Everything about the languages of this group must be accepted as provisional. We know neither the extent of the variety of the languages, their relation to each other, or their dialectical variations, nor have we full information regarding those languages, of which we have vocabularies or grammatical notes. We can hardly define the boundaries of the field of languages, and they have absolutely no literature. One thing is clear, that they cannot have been derived from one stock, though all, that are known, are agglutinative in structure. There must have been many distinct seedplots, for not only does the grammatical structure forbid the hypothesis of any original unity, but there is no such uniformity of vocabulary as would support the idea.

The region extends right across Africa in its broadest extent, from the West Coast to the Nile Valley, where, as stated above, the four groups meet, somewhere in the 4th or 5th degree of north latitude. Three great Negro tracts may be roughly hewn out:—1. The Western Coast; 2. The basin of the Chad; 3. The Upper Nile. The vast empty spaces on the map, both above and below the great Negro belt, warn us of the presence of a great *terra incognita*, and unrevealed millions.

This thought ought to make linguistic inquiriers and speculators into the origin of the human race and language silent and humble. We gather from the pages of Dr. Moffat, that new langnages were coming into existence under his eyes; and from the pages of Dr. Koelle, that old languages were dying out. Schweinfurth, Livingstone, Stanley, Nachtigall, Rohlf, and every explorer, bring back specimens of new vocabularies, or vague indications of new languages, not understood by their African followers. Even the vast collections in Dr. Koelle's monumental work, "Polyglotta Africana," resemble a handful of shells picked up from the sea-shore at random, and useless, until they pass under the hands of the skilful assorter, and some of them not of much use even then.

In this group we have many noble grammars, the work of great scholars; we have numerous translations of the Holy Scriptures, and plenty of religious and educational books; we have grammatical notices of the greatest value, by Frederick Müller, of thirteen of these languages in his "Grundriss der Sprachwissenchaft," and in his "Algemeine Ethnologie" we have the best classification of the group, that the materials available allow him to make. We find twenty-four sub-groups, to which I add another, for the dwarfs or pigmies. Of these, eleven sub-groups represent single and isolated languages, which admit of no relation to any other known variety. This by itself suggests, that the linguistic phenomena of the region have not yet been exposed to view. We do not find isolated languages, except in rare cases, elsewhere, and they generally are survivals of extinct families. The remaining fourteen sub-groups comprise a list of names, some of which are well known as the vernacular of great populations, such as the Susu, Vei, Temne, Yoruba, and Nupe, ahd others can, with difficulty, be traced in the pages of some traveller. Moreover, over and above these, there are other names to be gleaned from the journals of later travellers and missionaries. On the West Coast, the best known sub-groups are the Mandingo, Fulup, Temne-Bullom, Wolof, Bornu, Kru, Ewe, and Ibo. In these linguistic categories will come the French colonies on the Senegal, Sierra Leone, Sherborough Island, Liberia, the Grain Coast, Ivory Coast, Gold Coast, and Slave Coast, the kingdoms of Dahomé and Ashanti, and Bornu, Lagos, the Yoruba country, the basin of the Niger, as far as we know it right and left. In the Chad Basin, comes a sub-group of languages very faintly known. In the basin of the Nile and its great tributary, the Bahr al Ghazal, we find the languages of tribes of Bari, Dinka, Nuer, Shilluk, alluded to by a succession of travellers, and some of whom press upon the Hamitic, Nuba-Fulah, and Bantu groups, near the source of the Nile. Of the additional Pigmy group, we have some notices with regard to the Akka. As an interesting linguistic phenomena, it

is recorded, by more than one observer, that the peculiar liguistic feature known as "the click," generally connected with the Bushman, Hottentot, and the Káfir sub-branch of the Bantu family, exists in the speech of the races of the Upper Nile. This, coupled with the ethnical feature of the smallness of stature of some tribes, seem to indicate the existence of some aboriginal inhabitants antecedent to the present occupants.

We must recollect that the Negro type is a very marked one, and appears distinctly on the monuments of old Egypt 5,000 years ago, and though it may have undergone much admixture in the interior, it is pure on the coast. Of the purity of the languages, we cannot speak with certainty. The presence of the Nuba-Fulah from the north, the presence of the Mahometan religion in their midst, the influence of European nations and Americanised Negroes on the coast, must leave an influence. The Haussa is the great commercial language of Central Africa, far exceeding the limits of the region occupied by the Haussa race. It is an isolated language, and has borrowed from contact with Hamitic and Semitic races certain characteristics. It is spoken even as far north as Tripoli. It is attributed by one scholar to the Hamitic group, by another to the Nuba-Fulah, by a third to the Negro group. It might have been presumed, that there was a general consensus that these Negro languages were independent of any other group of languages; but so great a scholar as Bleek has laid it down, that some of the Negro languages actually belonged to the same family as the Bântu, and others were related to them. This shows how far we are at present from any certainty on any portion of the subject, from the absence of sufficient material.

V. The Bântu Family. The veteran, Dr. Krapf, claims the merit of the great discovery, that a single family of languages prevailed throughout Africa, south of the Equator, with certain reserved tracts for the Hottentot and Bushman. It was indeed a great discovery, announced by him in 1845, under the name of the Zinjian, a thoroughly unsuitable name, or Nilotic, a thoroughly inapplicable name. The name Bàntu, or "men" is now accepted. In spite of the wide spread of this family from shore to shore, there is unmistakable evidence in their genius, their phonetics, and their vocabulary, that all the languages had a common mother: they can be dealt with in the same manner as we deal with the Arian, Dravidian, and Semitic families. Some of the features of the common parent appear in each of the descendents. The language of the Ama Xosa, commonly called Káfir, is allowed, for the present, to occupy the first rank. However, we must remember that the linguistic and ethnical strata are not always uniform. Some tribes in Lower Guinea speak a Bântu language, through belonging ethnologically to a pure negro type.

The language-field of this family exceeds that of any other, but it would be unsafe to state any, even approximate, idea of the population. New tribes are being made known to us every year. It is entirely independent of any other type of language, having remarkable features of its own. It has been well studied by excellent scholars, both in detail, in separate languages, and as a family, by great comparative linguists, such as Bleek and Frederick Müller. It is distinctly agglutinative in method, but also alliteral, and subject to remarkable euphonic laws. It has on its frontier been influenced by alien neighbours, for we find in some languages clicks, borrowed from the Bushman; and on the north-eastern frontier Hamitic influences are felt in conterminous languages. However, so little is known for certain, that the development of this marvellous family must be left to the next generation. Frederick Müller confidently indicates Semitic and Hamitic influences, which must date back to the infancy of the language.

Dr. Bleek, who had actual knowledge of the subject, in addition to a profound knowledge of language generally, records his opinion on the characteristics of the family. The words are polysyllabic, and the syllables open: diphthongs rare; of derivative prefixes there were originally sixteen, but only two have a decided reference to distinction observed in nature, being restricted to nouns respecting reasonable beings, the one in the singular, the other in the plural number. The form of this latter is *ba*, actually or in some other manner obtained from it. There are few adjectives, and in their place, most generally, a participial construction is used. The genitive is devoted by a prefixed genitive particle. The cases are indicated by prepositions; different kinds of verbs are formed by variation of the ending and moods, and the perfect time are indicated in the same way. The most simple form of the verb is the singular of the imperative.

Dr. Bleek paid also much attention to the euphonic laws, which differentiated one language, or branch of language, of this family from the other. He showed that the languages differed from each other, more than the language of the Teutonic and Neo-Latin family differ from each other. The greater bulk of words in each language, though identical in origin, became wholly dissimilar, owing to the action of the euphonic laws which change their form. The grammatical forms are also very different. And this difference is to such an extent, that the Ama Xosa and Bechuàna cannot understand eacn other, though in the same branch of the family. Dr Bleek took pains to illustrate this new form of what he calls the great "Grimm" law of transmutation of sound in Bântu. There are three clicks in the language of the Kafirland sub-branch.

Some further explanation seems required of the euphonic or alliteral concord, which is so striking a feature; the initial element of the noun, a letter, or letters, or a syllable appears as the initial element of the adjective; the pronoun assumes the form corresponding to the initial of the noun for which it stands; the important part of the initial of the governing noun is detached to assist in forming the bond of connection with, and control over, the noun or pronoun governed in the genitive, *ex gratia.*

i Zimmi Zami Zi ya li Zua Lizai Lami.
Sheep (of) me they do it hear voice (of) me.

Bearing in mind that vast portions of the territory of the Bântu language field have only been imperfectly explored, or not explored at all, I adopt provisionally the classifications into three main branches, the southern, the eastern, and

western. Each of these are again subdivided into sub-branches, which are sufficient for present necessities, but which, as regards the eastern and western must be indefinitely extended as time goes on, to admit of proper classification of the scores of languages which come under observation. This classification is mainly dated on geographical data. In the southern branch there are three sub-branches (1) Kafirland; (2) Bechuána land; (3) Tekeza. In the first sub-branch we have the two great languages of the Ama Zulu, and Ama Xosa, commonly known as Kafir. It is the furthest removed from alien contact, and therefore the purest; the people understand the handling of their speech, and make long and orderly orations. It may be presumed, that this was the earliest stream of Bántu immigrants; the marked resemblance of the languages of the eastern branch with the languages of the western branch seem to indicate that they both belonged to a later and contemporary stream of immigration. Other languages are recorded in this branch, Ama Ponda, Ama Fingu, Ama Zwasi, and Matabêle, and north of the Zambési we come into contact with tribes called Maviti, Watuta, or other names, who are clearly of Zulu origin. It has been fully illustrated by scholars and grammarians, and there is a large literature.

The Bechuána-land sub-branch comprises the languages of the majority of the vast population which occupies the interior of Africa south of the tropic of Capricorn, intermixed with Bushmen and half-blood tribes. They are separated from the Kafir sub-branch by the Drakenburg range; southward they extend to the Orange River, westward to the Kalahári Desert, and northward as far as the Lake Ngami. Being powerful, they have brought under subjection tribes belonging to the eastern and western branches of this family. There are two divisions of this sub-branch, the eastern and western. The Eastern Bechuána tribes are the Basúto, who speak Sesuto; the Batan, who speak Setan; the Ba-tsetse, who speak Se-tsetse; the Ba-mapela, who speak Se-mapela; the Ba-puti, who speak Se-puti; the Ba-tloung, who speak Se-tloung; and others. The Western Bechuána tribes are the Ba-rolung, who speak Se-rolung; the Ba-hlapi, who speak Se-hlapi; the Ba-khwena, who speak Se-khwena; the Ba-kaa, who speak Se-kaa; the Ba-mangwato, who speak Se-bangwato; the Makololo; and the Marutse-Makonda, on the Zambesi River, described by Dr. Holub. The words of this sub-branch sound harsh, and its pronunciation offers a striking contrast to the melodiousness of the Zulu, to which language, however, it has a greater resemblance than to the Kafir. There are no clicks in this sub-branch; and there is an abundance of linguistic and educational works, for which we are indebted to the missionaries.

The third sub-branch of the southern branch is the Tekeza, spoken to the north-east of the Kafir sub-branch, and some distance to the north of Delagoa Bay, and in the neighbourhood of Lorenzo Marquez. A remarkable linguistic phenomenon is vouched for by Dr. Bleek, that the tribes occupying the entire coast-line of Zululand used to speak Tekeza languages, which they have abandoned in favour of Kafir. Some few of the Natal tribes are said to speak among themselves Tekeza languages. Clicks are unknown, except in those dialects which have come under Zulu influence. The southern and Zuluised tribes of this sub-branch are the Ma-neólosi, about 2,000 in number, in Natal; the northern are the Ma-tonga and Ma-hloenga, living near Delagoa Bay. The former seems to be a generic name for a variety of tribes inhabiting the interior of the Portuguese coast. Nothing has been published to illustrate the language of this sub-branch.

The eastern branch of the Bantu family is the creation of the last 20 years of exploration and missionary enterprise. The outlines of the great kingdom may be marked out with certainty; we must leave to future generations to fill in the details of the picture. No book that has passed under my observation has attempted it yet. I divide this eastern branch into three sub-branches:—I. The Basin of the Zambési. II. Zanzibár. III. Victoria-Tanganyika. Under each sub-branch will be given the boundaries assigned to their territory. The whole will make up the region included in this branch.

The first sub-branch, the Zambési basin, comprises an ever-increasing number of languages spoken by the tribes which come into contact with the missionaries, who have lately invaded that river and Lake Nyassa; the boundary of this sub-branch on the east extends north to an imaginary line separating it from the Zanzibár sub-branch, and on the west as far into Central Africa as exploration has extended. Considering the extremely scanty extent of materials, this grouping must be deemed entirely provisional, and only a convenient mode of collecting the names of languages known to exist in a certain territory. It is only by constant study of the narratives of travellers and missionaries that information can be gained, but the scientific character of the informants gives a value to what they state far beyond the random jottings down of the ordinary traveller. So far as it goes, it is accurate, but it goes only a very little way. We gratefully acknowledge a dictionary of some standing of the Nyâssa, by Dr. Rebman, and a modern grammar of that language, by Mr. Riddell, of the Free Church Mission. This is the language of Lake Nyassa, and, if cultivated, and made the vehicle of instruction, will extinguish its weaker rivals. The Makúa is a language of great importance, occupying the table-land betwixt that lake and the Mozambique coast; it has been illustrated by an accomplished scholar, Mr. Maples, of the University Mission. Adjacent to or intermixed with the above, is a tribe called the Yao, or Hiau, or Ajâwa, whose language has been illustrated by Bishop Steere. Vocabularies exist of most of the others, and their habitat is generally known.

The second sub-branch is the Zanzibâr; this extends from the island of Ibo, on the confines of the Mozambique territory, along the coast of the Indian Ocean, to the confines of the Galla and Wakuafi, where the Bántu family meet the tribes of the Hamitic and Nuba-Fulah groups already described. It embraces all the low coast, and the range of mountains running parallel to the coast, from the confines of the Zambesi sub-branch, to the country of the Masai of the Nuba-Fulah group. The dominant language throughout this sub-branch is the Swahéli, the speech of the coast,

as its name indicates, deeply affected by Arabic, used by Mahometans, and expressed in the Arabic character, and influenced by Arabic culture, but unintelligible to the savages of the interior. Those savage languages are being slowly developed by the labours of the missionaries. For the Swahéli all has been done, that is required, by Bishop Steere and Dr. Krapf, but of the other languages we have little more than brief vocabularies, or short notices, but it is a promise for the future to have got so much. It gives some idea of the rapidly expanding knowledge to mention that Frederick Müller only gives three languages of the sub-branch, which, owing to the diligence and energy of explorers, is now so rapidly expanding. It is pleasant to read in the reports that such a one is busy at the languages, has grammars and vocabularies, or a translation of a Gospel, in hand, all of which will find their way into my hands, and this is going on all down the line; and the funds are entirely provided by religious societies, who thus indirectly contribute to the extending of science.

The third sub-branch, that of the Victoria and Tanganyika Lakes, has been formed at a date entirely subsequent to the latest information available to Frederick Muller, and is the result of Stanley's famous journey across the Dark Continent, and the two great religious missions planted by the Church Missionary Society and London Missionary Society in answer to his challenge. If in five years so much has been done, what will be the result at the end of a quarter of a century? In connection with Victoria Nyanza many languages have been indicated, and their existence substantiated. In the language of the court of the King of Uganda, a portion of the Scripture has been translated; of the Nyamwezi we have a grammatical notice by Bishop Steere. The northern boundary of this sub-branch is the line of contact of the Negro, Hamitic, and Nuba-Falah groups already alluded to. On the east it is conterminous with the Zanzibár sub-branch, and to the south with that of the Zambési. To the far west an imaginary line must be drawn due south from Nyangwe on the Lualába (which Stanley proved to be the the Kongo), until it reaches the Zambési. Beyond that point the languages recorded must be entered in the western branch of the Bántu family, until, in due time, we have collected enough material to establish a separate group or family, as the case may be, for Central Africa south of the Equator, and north of the Zambési, which, with the exception of the track of Cameron, is now wholly unknown. In connection with Lake Tanganyika we have information from the south, owing to the exploration of the Geographical Society, and the visit of the Free Church Missionaries from Lake Nyassa. We have English missionaries established on one part of Lake Tanganyika, and French Roman Catholic missionaries at another. Nothing of a tangible linguistic character has reached us yet, but we are enabled to record the names and position of the tribes speaking distinct languages, or, possibly, dialects of languages, and leave it to time to fill in the picture. Nothing that is published can escape my observation, as every report, French English, or German passes under my notice.

The western branch of the Bántu family comprise the western half of Africa from the Namáqualand of the Hottentot family to the Equator, and beyond it to the island of Fernando Po, and the Cameroon Mountains on the main-land. The northern boundary is that of the Negro group; and to the east, the imaginary line drawn from Nyangwe to the Zambesi, thus leaving the blank spaces of Central Africa to the explorer from the west. This branch has three sub-branches (1), Angola; (2), Kongo; (3), Ogoway-Gabún.

The Angola sub-branch comprises the Herero of Damaraland, and the Shindonga of Ovampo, within British protection. and illstrated by grammatical and religious works. Crossing the river Cunéne, we enter the Portuguese settlements of Western Africa, and find a row of languages, of which our information is imperfect. Bunda is the best known, and is illustrated by grammatical works; but as to the language spoken in the interior, towards the kingdom of Muáte Janvo, we know nothing. Serpa Pinto has brought to notice the Gwanquella language, spoken in the basin of the Coanza.

Passing northwards, we come to the sub-branch of the Kongo, reaching into the interior as far as Niangwe. Stanley, in his "Dark Continent," has given us some glimpses of languages spoken on the Equator; and as we approach the Atlantic we have fuller information from missionaries and travellers. Stanley himself is in the field; and there are English and French missionaries pushing their way forward, and every year will add to our information. All those dreadful cannibals who obstructed the progress of Stanley down the Kongo will come into this category.

From the undefined confines of the sub-branch of the Kongo basin, to the frontier of Negroland, north of the Equator, stretches the sub-branch of the Ogoway-Gabún, including the islands of the coast, and the Cameroons. Here we have several well-defined languages, illustrated by several works of considerable merit; the Fernandian, the Mpongwe, the Dikéle, the Dualla, the Isubu, and the Bakéle. For every scrap of linguistic knowledge in these tracts we are indebted to the missionaries. The limits of the sub-branch may be indefinitely pushed into the interior; and on the confines of Negroland we may expect to find linguistic phenomena, a consideration of which may throw light into the origin of both the Negro and Bántu stock.

VI. Driven down to the extreme south of the continent of Africa, and only saved from extinction by the advent of the English, and by the efforts of Christian missionaries, we find the sixth and last linguistic group, and which, but for the smallness of the population, ought to form two groups, as the compenent parts have no relation whatever to each other. I allude to the group of the Hottentot and Bushman. Their existence is, however, important, as throwing some light on the character of the earlier, if not aboriginal, inhabitants of the continent, as, unquestionably, we have to deal with tribes broken and reduced by the powerful inroad from the north of the great Bántu family.

Sub-group "Hottentot." However, the word may be spelt, or from whatever cause assigned, it is not the real name of the tribe, who call themselves "Koikoib" (Men of men), and are called "Lawi" by their Kafir neighbours. They number 50,000, and are considered to have four dialects—Nama,

the purest and standard, spoken in Namaqualand to the north; Kora, on the Orange River; a third is spoken by the Eastern division of the tribe; and a fourth, and a very impure variety, in the neighbourhood of Capetown. To these must be added the Griqua, or Bastards, the issue of Dutch and Hottentot, speaking a mixed language. There are many excellent works by missionaries about and in this language, and it may be considered to be sufficiently well-known, and, in all probability, its days are numbered. Frederick Muller records his opinion, that it is an isolated language, with no connection with any other African or non-African form of speech, though morphologically agglutinative, the roots are monosyllabic; there are genders and numbers formed by suffixes; the pronoun is the vivifying element, and joined to nouns and verbs, differentiates the meaning. The oral literature consists of songs and animal stories, which have been collected by sympathising scholars. The great feature of the language is the existence of four clicks, formed by a different position of the tongue; the dental click is almost identical with the sound of indignation, not unfrequently uttered by Europeans; the lateral click is the sound with which horses are stimulated to action; the guttural click is not unlike the popping of a champagne cork; and the palatal click is compared to the cracking of a whip.

A variety of opinions may be quoted as to the ethnological origin of the Hottentot. Hovelacque declares that he is but a cross-breed, and that, whatever may be said to the isolation of his language, he has no pretence to independence of race. Max Müller quotes Dr. Moffat as an authority for a resemblance of the Hottentot language with that of some of the tribes of the Upper Nile. Such assertions must, at the present stage of the inquiry, be supported by actual proof at first hand, or withdrawn, as if supported only by hearsay statements, they are of no value. We must deal with actual facts, and in their absence, it is of no use hazarding theories of an archaic race extending in a continual line down the whole continent of Europe. No doubt the Hottentot and Bushman are like the Basque in Europe, the survival of an ethnological and linguistic stratum, which has disappeared elsewhere, and, in the absence of written records, left no trace behind. Bleek and Lepsius, whose names can only be mentioned with profound respect, connect the Hottentot with the Hamitic group.

The names of scholars whom we should aid to connect with this portion of the subject are, W. Bleek, Theophilus Hahn, Henry Tindall, Wallmann, and Frederick Müller. To them we are indebted for grammatical notices, vocabularies, and a considerable amount of educational and religious literature. A missionary being invited by the Government to send books in the Kora dialect to be printed, remarked, that his experience was that it was easier to teach the young to read Dutch, and that the old could not learn at all.

Sub-group "Bushman" comprises one isolated language, and is a very low state of linguistic development. The name was assigned to them by the Dutch, because they dwelt in the bush; they call themselves Saab or Saan, and are totally distinct from, and shunned by, the Hottentot and Bántu. The language belongs to the monosyllabic order, as far as we can judge; there is no gender, the formation of the plural is exceedingly irregular, and, of the sixty ways of forming it, reduplication of the noun is the most common, as the most natural; but the use of the plural seems to be as abnormal as the formation. In some particulars there are analogies common to the Bushman and the Hottentot. Dr. Bleek made many years' study of this subject, having members of the tribe in his household, and collected materials for grammar, dictionary, and folk-lore, before his premature death. We can only hope that his successor, Theophilus Hahn, will complete the unfinished work.

It must be remembered that the Bushmen are a broken and despised race, in the lowest state of culture, neither pastoral, nor agricultural, but living by hunting, and nomadic; they have no appearance of tribal unity, and no chief. Before the English rule they were treated as little better than wild beasts. The "click" sounds are believed to be their original property, and to have been communicated by them, in always decreasing proportion, to the Hottentot and Kafirland sub-branch of the Bántu family; for the Bushman, in addition to the four clicks already described as a feature of the Hottentot language, has a fifth, sixth, and sometimes a seventh and eighth, and not only before vowels and guttrals, but before labials. Such sounds are almost incapable of expression by Europeans, and it would almost appear that they are connecting links between articulate and inarticulate sounds.

The Bushmen are of exceedingly small stature, thus opening out the question of their belonging to the now well-established tribes of pigmies in North and Central Africa. In appearance they seem to belong to the lowest order of humanity; they inhabit outskirts and desert places, and are shy and wild. We read, however, of tame Bushmen, the Babomuntsu, on the outskirts of the Basuto country, and other tribes with mutually unintelligible languages, with evident traces of Bántu influence in their form of speech, both wild and tame, within the recognised territory of Bántu sub-branches. Only lately it was mentioned by Miss Lloyd, the sister-in-law of Dr. Bleek, that a Bushman, who resided beyond Damaraland, had come under her notice, whose language was unintelligible to the Bushmen at Capetown. Frederick Muller states that they are found even as far as the Rivers Cunéne and Zambesi, and even beyond. If such is indeed the case, we are not in a position to arrive at any final opinion about them.

One remarkable feature still remains to be noticed. No trace of the invention of writing has been found south of the Equator, but the Bushmen have acquired a wonderful power of painting scenes on rocks and in caves. Animals, human figures, dancing, hunting, fights, are pourtrayed with fidelity, and that the art has existed down to modern times is evident from the appearance of Boers in some of the fights. It appears that the art of sculpture was also known, and that the outlines of some of the figures are excellent.

Here ends my task. Twenty years ago there was a rebellion against the tyranny of the Arian and Semitic scholars, who attempted to cut down all languages to the length and breadth of their

method, forgetful of the infinite variety of the then dimly-discerned families and groups of agglutinating languages in Asia. The great problem of the origin of language, however, cannot be solved, and is not ready for solution, until the secrets of the languages of Africa, Australia, and America are revealed, and arranged in such order, that the lessons taught by the study of each of them may be considered with reference to the linguistic phenomena of the whole world, and this work will not be completed in this generation.

DISCUSSION.

Dr. Koelle said he could but express his delight at hearing that so much progress had been made in this country in the study of the African languages, since the time when he was occupied with the same subject, about thirty years ago. As an illustration, he might mention that, when he went to Sierra Leone in the year 1847, it was generally supposed that about thirty different languages were spoken in that colony, but his researches proved that there were upwards of 100. The Continent of Africa had been called dark, mysterious, and unknown, but it was now evident that it had, to a great extent, ceased to be unknown. Nevertheless, he was struck with the observation that, although we had made great progress in our knowledge of the Continent and its languages, there was still much to be done. For instance, it was mentioned that there were eleven unclassified languages, which showed that we might look forward to eleven new families of speech. As a matter of detail, he could not agree with the statement that the mode of writing adopted by the Vei people was not original, because it certainly had no connection with any other mode. It was a new invention, a syllabic mode of writing, and the Vei people had only a slight acquaintance with the European and Arabic methods, which were both alphabetical, consequently it was altogether new, and the marks themselves were also quite original. Mr. Hyde Clarke had traced some of them to the very old alphabets, but, as far as he could ascertain, there was no historic connection, only a physiological one. As far as the character of the writing was concerned, it was perfectly original. Again, the Negro languages were represented as being similar to the Turkish, as being agglutinative, but this would perhaps turn out not to be correct. For instance, the Damara language, which he had reduced to a grammar, was not agglutinative, and the same might turn out to be the case with a number of others. He was also struck with the remarkable character of the language in Darvar, of which he had an opportunity, some ten years ago, of collecting specimens from a black man in Jerusalem. it was a most singular language, but not agglutinative.

Mr. Cust asked if it were monosyllabic.

Dr. Koelle said no; it was exceedingly guttural, and the numerals were quite extraordinary, altogether different from those of any other African language with which he was acquainted. He hoped, from what had been already accomplished, that we might hope for still greater progress, for certainly a great deal yet remained to be done.

Mr. Hyde Clarke said he must join in the tribute which Dr. Koelle had paid to Mr. Cust for this paper, which all who had paid any attention to the subject would know must have involved an immense amount of labour. It did not appear to him that there was any need for apology for bringing it forward, and a full vindication was given, not only in the reasons he had mentioned, but in the very remarkable facts to which he had called attention. He had shown from the experience of the missionary societies that the simple propagation of religious tenets tended to the promotion of external science, and the labours of missionaries in East and West Africa were laying the foundation for the promotion of the arts and commerce which it was the object of the Society to foster. It was mainly by the study of the languages of a country like Africa, which possessed so many, that we could come into contact with the population and advance their material interest, as well as the spiritual interests, to which the labours of missionaris were devoted. Having studied and written a good deal on this subject, he might be excused for differing in some points from Mr. Cust, because he could only say, as had been already said, that from year to year we had to alter our opinions on these matters. For instance, on one point to which Mr. Cust had called attention, the languages of the short races of the Bushmen and the Akkas, for which he had the materials furnished him by the Italian Geographical Society, he was led at one time to publish the opinion that these languages formed an independent feature, that there were assuredly relationship between the various short races in the world. Wider consideration, however, of the real nature of language, had led him to materially alter his opinion. So far as race was concerned, it was a matter well worthy of attention, that right across Africa there was a series of these short races, and that they were found in other parts of the world, speaking languages which indirectly were of common origin. He regretted that he could not accept the explanation of the distinguished scholar, Frederick Müller, as to hair having any connection with the distribution of language; but must accept the contrary dictum of Mr. Cust, that language could not be admitted in any way as a testimony of race. When that great scholar came to make further examination, he would find that the very languages which he had attributed to populations having one character of hair, spoken by others partaking of different ethnological constitutions. As to tufted hair, anthropologists considered it was artifically produced. Latterly he had been compelled to attend more to the two groups which Mr. Cust called the Nubah and the Negro, and, as far as his experience went, there was no black population in the world but spoke a language which, to all intents and purposes, might be termed a white language, and there was no white population but spoke what, if you chose, you might call a black language. In the preface to the most remarkable grammar of the Bornu language, by Dr. Koelle, he gave most decided specimens of the relations of those Bornu words and forms of grammar to the other languages of the world, and he might have carried that still farther. He himself had gone the length of saying that the Houssa language might be compared, in more than 200 words, with the Kolarian. Thus, you might compare the language of the Santals, who were lately in rebellion against us, with that of the Houssas, whose assistance we hoped for in the threatened war on the West Coast. It would, he thought, be a great advantage to the missionary cause, if a missionary from that district were sent to labour for a time among the tribes in India. In the grammar of another distinguished scholar, the Rev. Mr. Schön, there was an observation bearing on this point. He had studied this subject quite free from all prepossessions, and must be pardoned for differing from many great authorities, and he could not but say that, in the main, he found all the languages of the world, not even excepting the Bushmen and Hottentots, had a common connection. Then came the difficulty which had been put forward, how was it possible that languages could be related which differed so much in their words; surely there could be no affinity between languages having such different vocabularies. But, as Dr. Koelle had pointed to the confusion between agglutinative and inflexional languages, so it would be found that the grammatical forms distributed throughout the world were connected in a similar manner. The question to be determined was, whether i

was correct, according to the old system, to assume that there was one primitive language of one set of radicals, or whether, on the other hand, there was was a system of language, in which several words were attributed to one idea, and possibly several ideas to one word. Mr. Cust knew that even with regard to the Egyptian and Coptic, there were several words with more than one idea attached to them; and so it was with all the pre-historic languages, whether you went to the Caucasus, to Africa, or to America; for it had been brought out by the researches of the American department, that the same feature prevailed in the sign languages of the American Indians. If it were the case that there were many signs used for one word, there might well be a very varied distribution of sounds. Then came another question, how was it possible to bring together, correlate, and compare these discordant materials. There he thought Mr. Cust might well have applied to other very distinguished scholars in Germany, who were studying psychological philology, such as Dr. Karl Abel. They studied not only sounds, but the ideas represented, and thereby they obtained further criteria; they found two ideas connected which were represented by one sound, and another sound likewise representing those two ideas; so that we got, in the end, a means of checking other observations, and arriving at exact results from discordant materials. In conclusion, he would say, that this subject was of great practical value to the future development of Africa, besides being a matter of the greatest moment for the progress of philology and anthropology. Mr. Cust had briefly pointed to one historical reason for this. Africa had never been conquered by those great conquerors who altered the anthropological and linguistic boundaries of Europe and Asia, but these tribes had been preserved. It was necessary, however, to guard against the confusion of race with language. It by no means followed because we found a negro population speaking a particular language, that that must be the language of that race. Therein, he thought, lay a great part of the fallacy of Frederick Müller. In Liberia or Sierra Leone there were large negro populations speaking English, and we knew how they had obtained that language, but there were similar populations in a state of utter savagery, speaking languages of equal culture, although of a different form, which could be correlated with the remains of other languages of antiquity. In fact, we had living languages for the illustration of Kluta, Babylonian, Etruscan, Cypriote, Iberian, and what was once most celebrated, and now most obscure, in the ancient world.

The Rev. W. Wright (of the Bible Society) thought the great practical value of this paper was that Mr. Cust had shown as it were the tide-mark to which scholarship had risen on this subject, and it would be very interesting in a few years to have a similar paper, showing how much progress had been made in the meantime. It was interesting now to look at old maps of Africa, and see what was known nine or ten years ago, and then take maps brought up to the present state of knowledge, and mark the difference. He was much pleased with the scientific manner in which Mr. Cust had treated the subject; not dogmatically, for dogmatisms were generally put forward by men who thought they knew all about the subject, simply from their ignorance of what the considerations of the problem were. On the following day he should have to lay before the committee of his Society a letter from Bishop Steere, showing that his assistants were all working like bees, and the New Testament was now completed. Redman did the Gospel of Luke, but Bishop Steere completed the other parts. Mr. Hyde Clarke would also be glad to hear that the New Testament had been completed in the Houssa language, and that the Old Testament was in progress. He must correct one statement in the paper, viz., that Bishop Steere was the author of the gospel in Yah; it was Mr. Maples. He also thought it would be well for Mr. Cust to suspend his opinion as to what part of the world we owed language to, until more was known about the inscriptions now being published by the Biblical Archæological Society. The whole Bible was now being printed in Basuto, and the work was going on in the Yoruba, and several other languages. He might promise the whole literary world that any translation made in Africa that came to the Bible Society attested they would print. He hoped that in the future, when kindly missionaries went into the country, and kindly explorers, instead of the greedy adventurers who had preceded them, and the more cruel imperialism that had touched the country at different points, they would stir up a kindly response in the hearts of the people, and that the travellers would be received into the country, and be able to explore, to their roots, the different languages.

Mr. Brandram said he had read about the African languages, as a student, but he had no special knowledge of any of them. Of late he had turned more attention to them on account of the light which they threw on the gender. This question of the classification of languages in accordance with the gender, had nothing to do with their relationships amongst themselves necessarily; but they apparently learned more about gender from these African languages, than from any other in the world. They saw it there completely developed, and apparently in embryo; and although those who studied the matter might hold the most opposite theories, it was to the languages of Africa they all appealed. He had classified the African language, for his own satisfaction, into three divisions; the Hamitic and Semitic, as having the most highly developed gender, in which the distinction of sex was the basis; then there were the Bântu languages, in which the distinction was based rather upon animate and inanimate considerations; and then there were the Negro languages in the centre, in which there was no distinction of gender at all, except the embryo, in the shape of prefixes and suffixes, which, according to Dr. Bleek, might ultimately develop into gender. He must add his testimony to the great value of the paper, in which all the information existing on the subject was brought together, and the authorities were referred to; a work of immense service to students, who otherwise might waste valuable time in doing what had been done already. He believed Mr. Cust was now doing for the African languages what he had already done for the Asiatic, and he begged to thank him for it.

Mr. A. W. Mitchinson, author of "The Expiring Continent," said that philologists were often in error in their explanations of the derivation of roots of languages. This arose from depending too much on theories and book-knowledge alone. A more accurate idea could be obtained only by personal acquaintance with natives. He had met Bushmen in Africa, whose words were the same as those of other tribes far distant on the same continent. The character of the country and population had altered since ancient times, and this had led the philologists to erroneously ascribe the origin of language to several places instead of one. The migration of people from one country to another influenced the character of the native languages. He found in his travels in Senegambia, on the Gambia River, and in Equatorial Africa, that many words as *osoka*, *otchag*, *idoo*, *tega*, &c., were both in meaning and sound exactly the same as Russian, Persian, Arabic, Hebrew, and other Oriental languages. The speaker mentioned that some of the natives in Africa had tails four or five inches long, derived, according to the tradition of the natives themselves, from gorillas or "devils," who had stolen native women. He concluded by denying that any of the natives of Africa were cannibals, except in cases of starvation, but stated that on the other hand they were great dog-eaters.

Dr. Mann remarked that the skill of the Bushmen in drawing, to which reference had been made, was a matter of considerable interest, and he himself had had some opportunity of noticing it. At one time, in the neighbourhood of Natal, there were a number of Bushmen who gave a deal of trouble, by coming down at night on the frontier of the colony, stealing horses and driving them away to the caves which they inhabited in the mountains. After some time, consent was obtained to send an expedition out to disperse them, and in a skirmish some were wounded, one of whom was taken prisoner. He appeared to be a lad, though it was not always easy to tell who were boys and who were old men. Having been cured of his woundsin the hospital at Pietermaritzburg, he was taken charge of by one of the magistrates, Mr. Proudfoot, with whom he lived for several years. This lad was very skilful in drawing, and it was often an amusement to call him out, and get him to show how he did it. He began by simply placing a number of isolated dots on the slate, or whatever he had to draw upon, which then resembled a constellation of stars; then after pausing, and carefully looking at these dots, he would carefully connect them together, until an animal grew up out of the outline, and you could tell at once what it was, whether a horse, a buffalo, or an antelope. He stated that that was the invariable mode of drawing, and he, Dr. Mann, had some reason to believe that it was so. A short time since, Mr. Francis Galton having expressed great interest in the matter, and a desire to have the facts carroborated, he had written to Mr. Proudfoot to ask if he could send him some drawings, but unfortunately he found that the poor fellow died about two years since of consumption. From his acquaintance with this man, he very much doubted the generally accepted notion of the very low organisation of the Bushmen. Though small in stature, they were quick in perception; and though their craniology was peculiar, it did not appear to indicate low organisation. This question was a very difficult one. One of the finest collections of skulls in the world was that of the Royal College of Surgeons, and some little time since he obtained five characteristic skulls of Zulus, from the field of Isandhlane. All those five were of a very distinct type, and Professor Flowers said a Zulu skull might be detected anywhere after having seen them; yet one of those sculls was, with one exception, the largest in the whole collection, though it belonged to a man who would probably be spoken of as a low organisation savage. Why the Kafir and Negro races, with such fine crainal development, were so backward in social civilisation, he did not undertake to say, but it certainly was not due to lowness of organisation.

The Chairman, in proposing a vote of thanks to Mr. Cust, said he could not pretend to any knowledge of the philological questions treated, but other gentlemen present, who were able to judge, had spoken upon this topic. His only excuse for occupying the chair was that, while at the Cape, he took a great interest in the ethnology of the various native races, and that he was fortunate enough on his return to be able to give Mr. Cust some materials which were of use to him. He also had the pleasure of being intimately acquainted with the late Dr. Bleek, and he need hardly say that he did all in his power to forward his investigations, especially in connection with the Bushman language; and he agreed with Dr. Mann that that was a most remarkable tribe, and by no means one of the lowest in organisation. It must be interesting to the Society of Arts to know that it was owing to a former President, the late Prince Consort, that Dr. Bleek was able to go to South Africa at all to prosecute his researches, and he might add, that for several years he received aid from the Prince's private purse. While out there, unfortunately, his untimely death put a stop to his studies, except so far as they were continued by his sister-in-law, Miss Lloyd; but he was glad to hear that the Cape Government had now filled up his place by the appointment of Mr. Theophilus Hahn, who was highly recommended by Professors Max Müller and Sayce, and from his linguistic requirements and experience in the interior, they might look for great results. He was surprised to hear that so much remained to be done in almost every part of the dark continent, especially amongst the Bantu tribes of Central Africa; but Mr. Cust had rendered good service by classifying and putting into a condensed form all that was known about these languges, and his paper would serve as a sort of sketch for travellers and missionaries going to Africa. He had very properly reminded them of the debt they owed to the various missionary societies, without whose aid very little of what he himself and other students had accomplished, would have been possible.

The vote of thanks having been passed unanimously,

Mr. Cust, in reply, said he hoped one good result of the paper would be that Dr. Koelle would awake from his slumber of 25 years, and again turn his attention to the subject of the African languages. If he would take up his own book as a basis, and add to it the fruits of his later experience, he would be doing invaluable service.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 2nd, 1881; Frederick J. Bramwell, F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Appleby, Herbert, Durnlea, Littleborough, Lancashire.
Attwood, George, F.G.S., F.C.S., 7, Ulster-place, Regent's-park, N.W.
Hall, W. H., Weybridge-heath, Surrey.
Rattray, Netlam, 70, Gloucester-terrace, Hyde-park, W.
Richardson, Captain John Frederick, Ph.D., J.P., Houghton-house, Stoneygate, Leicester.

The following candidates were balloted for, and duly elected members of the Society:—

Branston, F. R. E., 23, St. Swithin's-lane, E.C., and 66, Lillieshall-road, S.W.
Dollman, Charles, 293, Clapham-road, S.W.
Greenwood, A., LL.D., Flaxfield College, Basingstoke.
MacCallum, Andrew, 47, Bedford-gardens, Kensington, W.
Wilding, Samuel P., 23, Rood-lane, E.C.

The paper read was—

LIGHTHOUSE CHARACTERISTICS.

By Sir William Thomson, D.C.L.

For a lighthouse to fulfil the reason of its existence, it must not only be seen, it must be recognised when seen. Besides its light, a modern lighthouse generally contains also, for use in such thick or foggy weather that the light cannot be seen, a sound-making appliance, the object of which is not only to be heard, but when heard to be immediately recognised to be itself and nothing else. Mr. Price Edwards, in his commuication to the Society of Arts, of 15th December last, on "Signalling by means of Sound," gave an interesting and clear description of the chief practical methods hitherto in use for this exceedingly im-

portant addition to the efficiency of light-houses; and I shall have occasion to return to the subject of characteristic sounds, in relation to the several methods which have been adopted to give characteristic qualities to the light itself of a light-house.

Setting aside colour, now generally admitted to be indefensible, as a distinction for lighthouse lights, except in the proper use of it, which is to distinguish different directions of the light by coloured sectors to mark rocks or other dangers, or the safe limits of navigable channels, we find all the characteristic qualities of lighthouses to come under one or other of the following three descriptions:—

I. Flashing lights.
II. Fixed lights.
III. Occulting or eclipsing lights.

The well-known name "Revolving lights" is habitually limited to flashing lights; but it is liable to ambiguity, because the same revolving mechanism is also applied in many cases to produce the eclipses of "Occulting or Eclipsing lights." The official description of the revolving light in the "Admiralty List of Lights," is as follows:—

"*Rev.* Revolving light, gradually increasing to full effect, then decreasing to eclipse. [At short distances and in clear weather a faint continuous light may be observed.]"

This, in fact, includes the description of the flashing light:—

"*Fl.*—Flashing—showing flashes at short intervals, or groups of flashes at regular intervals."

A combination of the fixed and flashing qualities, though comparatively rare, constitutes an important characteristic light, described in the Admiralty list as follows:—

"*F. and Fl.*—Fixed light with addition of white or coloured flashes, preceded and followed by a short eclipse."

Thus we have really very little of complexity in the fundamental classification into the three descriptions of Flashing, Fixed, and Occulting.

In the flashing light, the light is visible for only a short time—a fraction of a second, or from that to five or six seconds—and then disappears; and, for a much longer time than the duration of the flash, it remains invisible, until it again flashes out as before. In the fixed light there is no distinguishing characteristic whatever, but merely a light seen shining continuously and uniformly. The occulting light is visible during the greater part of its time like a fixed light, shining continuously and uniformly. Characteristic distinction is given by a short eclipse, or by a very rapid group of two or three short eclipses, or of short and longer eclipses recurring at regular periods, "flashes of darkness," as they have been called, cutting out, as it were, from the light its mark, by which it may be distinguished and recognised to be itself and nothing else, in the very short time (from half-second at the least, to seven seconds at the most) occupied by the group of eclipses.

I.—Flashing Lights.

Six years ago, in every flashing light there was just one flash in the period, and thus the length of the period was the sole distinction between one flashing light and another. Thus, in the "Admiralty List of Lights for the British Islands," for 1875, we find about 100 flashing lights of different periods, from the four-seconds' period of Ardrossan Breakwater light to the two-minutes, period of the upper light of Lundy Island, of the South Stack, Holyhead, and of one of the lights on Slyne Head, off the west coast of Ireland; and the distinction of each one of these 100 lights was solely its period as a simple flashing light, except in cases in which the objectionable distinction by colour was put in requisition. When it was determined to choose periods the same, or nearly the same, for neighbouring lights, it was found necessary to add distinction by colour, objectionable as this is if not enforced by necessity. Thus, for for example, the Gull Stream lightship, in the fairway between the Goodwin Sands and the Kentish coast, is a revolving light of twenty seconds period, while the East Goodwin lightship, about six miles from it, is a revolving light of fifiteen seconds period. Without greater accuracy than is generally to be found in the time-keeping of flashing lights, even on shore, the distinction between fifteen and twenty seconds could scarely be relied upon, as given by the mechanism; and even if given trustworily by the mechanism, the distinction could only be discovered by the sailor with certainty by the aid of a chronometer. To give a sufficient distinction between these two lights, therefore, it was found necessary to use colour; the East Goodwin was made green, the Gull Stream white. Again, the St. Agnes light, Scilly, and the light on the Wolf Rock, two far outlying lights, about twenty miles asunder, are each of them of half a minute period from flash to flash, and the sole distinction between them is, that the flashes of the Wolf light are alternately white and red, while those of the St. Agnes' light are all white.

The insufficiency of the distinction of flashing lights, merely by length of period, had come to be felt so strongly, that a very important fresh distinction was introduced in 1875, in the lightship then first placed on the Royal Sovereign shoal; the Group Flashing Light of Mr. Hopkinson, in which, instead of just one flash in the period, there are, in the case of the Royal Sovereign light, three flashes in the period, or, as may be in other cases, two flashes, or four flashes, the interval between the successive flashes of the group being much shorter than the interval from group to group in the whole period. In two cases in the English Channel, the North Sand Head and the Casquets, the new triple flashing light was introduced, to replace, by a group of three flashes in rapid succession, three separate lights which had been the characteristic arrangement previously; three fixed lights in the case of the North Sand Head, and three simple flashing lights in the case of the Casquets.

Mr. Preece has imprudently pointed out that Mr. Hopkinson's triple flashing light is the letter S of the Morse-Colomb flashing alphabet. Sailors, we may hope, are happily ignorant of this truth. The proverbial captain of the collier does not read the *Journal of the Society of Arts*, or he would be calling out to his chief officer —"Bill, was that a S, or a I, or a H, or a E.?" Bill, if he was well up in dramatic litera-

ture, would reply, "Captain, them is things as no fellow can understand." I must say, however, that I agree with Mr. Preece, and think that, while many may find memory aided, none can be embarrassed, by an official statement of the Morse letter corresponding to any group of flashes or eclipses that may be chosen as the characteristic for any particular light. This, however, is a matter of comparatively small moment at present. The great thing is to find how lights may be most surely and inexpensively rendered distinctive, so that no sailor, educated or uneducated, highly intelligent or only intelligent enough to sail a collier through gales, and snowstorms, and fogs, all winter, between Newcastle and Plymouth, may know each light as soon as he sees it, without doubt or hesitation.

This object is fully attained by the triple flashing light, if quick enough. The triple flashing light of the Casquets, and of Bull Point (Bristol Channel), which are the quickest of the kind hitherto made, complete their three flashes in twelve seconds, after which there is an interval of eighteen seconds of darkness. These are, no doubt, very admirable and thoroughly distinctive lights; but it would be very much better if they were made three times as fast, which, with the existing machinery, could, I believe, be easily done. If this were done, they would show their flashes each in two thirds of a second, and with only a second of time between. Thus, the three flashes completed in four seconds, would be instantly recognised as a group of three, without the necessity of any counting either of flashes or of numbers of seconds of time in the intervals between the flashes; and, instead of having to wait in darkness for eighteen seconds the sailor would only have to wait six seconds, for a repetition of the triple flash.

The *Royal Sovereign*, the *Seven Stones*, the *Newarp* (near Yarmouth, on the east coast), and the *Saltees* (off the south coast of Ireland), all lightships, supplied within the last few years with the Triple Flashing Light, are, each of them, of one minute period, of which there is thirty-six seconds of darkness, and twenty-four seconds of flashing. These lights are all too slow to do full advantage to the Triple-flash system. When one of them is first seen, it is very apt to be confounded with an ordinary "revolving light;" that is, a single-flash flashing light. Even somewhat careful watching—at all events if the weather, or the distance from the light, be such as to leave any room for doubt—does not always immediately resolve the doubt. A sixfold quickening of each of these lights would greatly enhance its distinctive quality, and would make it really fulfil the condition pointed out by the Elder Brethren of the Trinity-house, as the object to be aimed at in every modern lighthouse, "That he that runs may read."

The satisfactory distinctions of Group-Flashing lights are exhausted in the groups of two or three or four flashes: because, to count five or six, or more, would be embarrassing, and liable to mistake at sea. It has been proposed to obtain further distinction, by using groups of longer and shorter flashes, as in Captain Colomb's Flashing Telegraph, now in general use, and very thoroughly appreciated both in the Navy and in the Army; but there are optical difficulties in the way of making, with satisfactory economy, groups of long and short flashes, separated by short intervals of darkness in the group, and comparatively long intervals of darkness between successive groups; and considering how very much more useful and satisfactory at sea is a light-house showing long light with short intervals of darkness, than even the quickest of flashing lights, it does not seem desirable to push the distinctions of flashing lights further than the double, triple, and quadruple groups. The periods for these lights, which seem best adapted for practical purposes, all things considered, but most particularly their value to the sailor, are as follows:—

Number of flashes in period.	Duration of each flash.	Duration of group.	Whole period.
One............	$\frac{1}{4}$ sec.	$\frac{1}{4}$ sec.	2 sec.
One............	$\frac{1}{2}$,,	$\frac{1}{2}$,,	4 ,,
One............	1 ,,	1 ,,	8 ,,
Two	$\frac{1}{2}$,,	2 ,,	6 ,,
Two	1 ,,	4 ,,	12 ,,
Three	$\frac{1}{2}$,,	$3\frac{1}{2}$,,	9 ,,
Four	$\frac{1}{4}$,,	$2\frac{1}{2}$,,	8 ,,

It may be objected to the suggestions of the preceding table, that the quarter-second flashes are too short to be perceived with the same certainty as flashes of five or six seconds duration. Experiment alone can answer decisively the question whether, with equal maximum brilliancy in each flash, a flash of quarter-second duration recurring every two seconds, or one of half-second recurring every four seconds, or one of one second recurring every eight seconds, is the most easily to be seen at a great distance, or in hazy weather. From physiological experiments already made, it has been concluded that one-tenth of a second is a long enough time to fully excite the sensibility and perceptive power of the eye, and it seems probable that rapidity of recurrence of the contrasts between light and darkness will give a positive advantage to the quicker flash, in respect to perceptibility, even when the observer knows in what direction to look for the light; and when he does not know exactly in what direction to look, which is the practical case of a sailor at sea trying to pick up a light, shortness of the time of invisibility is of supreme importance. All things considered, it seems most probable that the quarter-second flash recurring every two seconds, will be very much more easily and surely picked up practically at sea than a flash of one second recurring every eight seconds.

Before passing from this subject of flashing lights, I may be allowed to say that I first received my impression of the vital importance of quickness in a light from a very practical man, the man who, in 1866, showed us within a quarter of a mile, in mid-ocean, where to find the cable which had been laid and lost in 1865, Captain Moriarty, R.N. I well remember when, on one occasion, either in 1858 or 1865, I do not know which, in making the Irish coast in dirty weather he said:—

"Those lighthouses should flash out their characters like your electric signals; every lighthouse should flash, and flash, and flash, many times in a minute, showing you which lighthouse it is every time. That long

minute of the revolving light has often seemed to me like an age, when I have been anxious to make out where we were in a gale of wind and rain."

II.—FIXED LIGHTS.

Of the 623 lights numbered in the "Admiralty List of Lights for the British Islands for 1881," 490 are fixed, 112 are flashing, and 21 are occulting (or "eclipsing," or "intermittent"); and similar proportions are to be found in the official list of lights for other parts of the world. Thus it appears that fixed lights constitute the great majority. The fixed light has a great advantage in respect to practical usefulness over the flashing light, in being always visible. The superior brilliancy produced by optical condensation of the revolving light is, in some respects, dearly bought economy, when the great diminution of usefulness to the sailor, in its comparatively long periods of darkness, is taken into account. Theorists who praise the revolving light unqualifiedly for its superior penetrative power, seem to forget the counterpart in optics to the great principle in dynamics—that what is gained in power is lost in speed: in flashing lights, what is gained in brilliancy is lost in time of visibility. The painfully anxious scanning of the horizon for a one-minute flashing light, is known to every one who has ever had occasion to look for one in practical navigation; and the comparative ease of picking up a fixed light, and keeping sight of it when it is found, in difficult circumstances, is thoroughly appreciated at sea by sailors. Still, if the revolving light can be seen at all, whatever be the difficulty in picking it up, and whatever the annoyance of losing sight of it and having to pick it up again, it has fulfilled the object of a lighthouse. All are agreed in the maxim that "the grand requisite of all sea lights is penetrative power;" and if the fixed light cannot be seen at a distance, or in weather in which the revolving light is seen, the fixed light has failed, and the revolving light has done its work for the occasion. It depends very much on the special circumstances whether the same quantity of light, given out uniformly as a fixed light, or condensed and given out in flashes, with comparatively long intervals of darkness, as in the revolving light, is better in respect to being seen. In stormy or variable weather, with heavy showers of rain or snow, the fixed light is much safer than a one-minute revolving light of much greater absolute brilliancy, as several successive flashes of the revolving light may be lost through passing showers, while the fixed light loses no chance of being seen in intervals between the showers. On the other hand, in hazy or foggy weather of tolerably steady character, a revolving light can be seen efficiently at a greater distance than the same absolute quantity of light, given out uniformly as a fixed light.

In the question of economy, the great first cost of the optical apparatus, special to the revolving light, must be set against the greater consumption of oil, or gas, or fuel, to obtain in a fixed light, whether it be an oil or gas lamp, or an electric light, the same brilliancy. In many cases, indeed, the interest of the money spent on prisms, and lenses, and mechanism in the revolving light, and in some of the most beautiful and perfect of the appliances for the azimuthal condensation of fixed lights, would supply the oil required to give the same, or nearly the same, brilliancy all round the horizon. These circumstances are, of course, all to be taken into account by the proper authorities in respect to every project for a new lighthouse. But we have actually at present the great fact of 490 fixed lights on the coasts of the British Islands; and when it is considered desirable or necessary to give more brilliancy to any of them, this certainly is not to be done by converting it into a flashing light, but by making it a more powerful oil or gas light, or converting it into an electric light. Indeed, after Mr. Douglas's communication of two years ago (March 25th, 1879) to the Institution of Civil Engineers, on "The Electric Light Applied to Lighthouse Illumination," and the discussion which followed upon it, and considering the great progress which has been made since that time in lighting by electricity, we can scarcely doubt that, in the course of a few years, nothing but the electric light will be thought of for any new lighthouse of great importance.

The great defect of fixed lights at present is the want of characteristic quality by which the sailor, when he sees a light which really is a lighthouse light, may immediately feel sure that it is so, and not a steamer's mast-head light, nor a trawler's or fishing-boat's light, nor a light on shore other than a lighthouse light; and that knowing it to be a lighthouse, he may know exactly which of two or more possible lighthouses it is. The need for thorough-going remedial measures to remove this defect has been more and more felt of late years, and is now very generally admitted. Unless a second light is to be added, or the generally objectionable expedient of colour for distinction is in any particular case to be admitted, the only systematic means of giving characteristic quality to a fixed light is by means of occultations or eclipses; and hence the origin of the "Occulting" or "Eclipsing light." We may accordingly look forward to all, or nearly all, the important fixed lights of our coast being, without any very long delay, converted into lights of this class. It is satisfactory to find that during the last year the elder brethren of the Trinity-house converted one most important light, that of the North Foreland, and another very important one, the light on the west end of Plymouth Breakwater, into eclipsing lights, and that a similar improvement has been promised for five more of the fixed lights under their charge (Mucking, Lowestoft, Chatham, Flatholm, and Evan) within the official year 1880-1.

III.—OCCULTING OR ECLIPSING LIGHTS.

The 21 eclipsing lights at present existing in the British Islands are described in the Admiralty list of lights. (See next page.)

To these is to be added the Cardross light on the Clyde, at present a red light, but which, before the end of next month, is to be converted into a white eclipsing light of the same character as the Craigmore light in Rothesay Bay, long-short-long-short. It was judged by the trustees of the Clyde Navigation, under whose charge this light is, that the long-short-long-short would be thoroughly free from liability to be mistaken for the occulting light (short-short) off Garvel Point,

Occulting Lights of the British Islands, 1881.

No.	Name.	Place.	Period.	Remarks.
12	Plymouth	On W. end of breakwater	Half-minute.	The light suddenly disappears for 3 seconds every half-minute.
107	North Foreland	On head	"	The light suddenly disappears for 5 seconds every half-minute.
[illegible]	Tarbet Ness	430 yards from the extremity of the point	3 minutes.	Visible $2\frac{1}{2}$ minutes, eclipsed $\frac{1}{2}$ minute.
305	Ru Stoer	South ear of Ru Stoer	$1\frac{1}{2}$ "	" 1 " " $\frac{1}{2}$ "
315	Hebrides, Barra Head	Highest part of Bernera Island, South point of the Hebrides.	3 "	" $2\frac{1}{2}$ " " $\frac{1}{2}$ "
[illegible]A	Craigmore, Firth of Clyde	End of pier, Bogany point, Bute Island	11 seconds.	Five seconds of light, followed by four eclipses, long-short-long-short.
347	Greenock	Garvel point	8 "	Light for four seconds, with two short eclipses in the next four seconds.
361	Troon Harbour	Inner end of pier	1 minute.	Visible 40 seconds, eclipsed 20 seconds.
373	Galloway Mull	S.E. extreme	$\frac{3}{4}$ "	" 30 " " 15 "
418	Ribble River	S.E. of Stanner point, N. side of entrance	4 "	" $3\frac{1}{2}$ minutes, " $\frac{1}{2}$ minute.
442	Lynus	On the point	10 seconds.	" 8 seconds, " 2 seconds.
454	St. Tudwall	West Island	10 "	" 8 " " 2 "
494	Bristol Channel Burnham	E. side of entrance of Parret River	4 minutes.	White with Red Sectors, visible $3\frac{1}{2}$ minutes, eclipsed $\frac{1}{2}$ minute.
512	Cork Harbour	Roche point, E. side of entrance...	20 seconds.	" 15 seconds, " 5 second.
521	Mine Head	S. side of head	1 minute.	" 50 " " 10 "
536	Wicklow	On the head	13 seconds.	" 10 " " 3 "
542A	North Bull, Dublin Bay ...	End of North Bull wall	14 "	" 10 " " 4 "
555	Dundrum Bay	St. John's point	1 minute.	" 45 " " 15 "
562	Belfast Bay	On elbow of Hollywood bank in 8 feet water	12 seconds.	Eight seconds of light, followed by two short and one longer eclipse.
566	Rathlin	Altacarry head, N.E. point of island	1 minute.	White with Red Sector, visible 50 seconds, eclipsed 10 seconds.
600	Loop Head	500 yards, E. by S., from extremity of head	24 seconds.	" 20 " " 4 "

three miles from it, and would, in the circumstances, give it a more telling characteristic quality than a single eclipse in the period or than any group of three eclipses.

It will be seen, from the preceding table of occulting lights that, with the exception of Holywood Bank light, Belfast Lough, and Garvel Point, and Cardross lights, all on the Clyde, the distinction in each case is only a single eclipse in the period, and that except in nine of them, the period is one minute or upwards, but in all, except five, the duration of the eclipse is less than half a minute. In all the more recent eclipsing lights the period is half a minute or less, and the duration of the eclipse is at most five seconds. The tendency undoubtedly is to quicken the action still farther, following the example of the old Point Lynus light, with its eight seconds of visibility and two seconds of eclipse.

The necessity for a very short period is not so urgent in the case of eclipsing lights as it is in the case of flashing lights. A long period in the case of a flashing light means a long period of darkness, throughout which the light is lost sight of. The inconvenience of a long period in an eclipsing light is merely the length of time during which the sailor may have to wait to know which light it is; he never loses sight of the light except for the two or three seconds' duration of one of the eclipses. But quickness of each group is just as important to allow ready and sure identification of its character as is the quickness of a group of flashes in the group-flashing lights, of which I have already spoken.

The important question is now to be met—How may eclipses be best arranged to give the requisite number of characteristic distinctions, for the large number of fixed lights on our coasts which need distinction, with as little as may be of interference with the valuable quality of fixity? The answer, I believe, is by groups of eclipses described as follows:—First—one, two, three, or four very short eclipses, say of not more than one second each, separated by equal intervals of light in the group, and the groups of eclipses following one another after intervals of not less than eight seconds of undisturbed bright light; next groups of two or of three short and long eclipses, the short eclipse one second, the long eclipse three seconds, the interval of light between the eclipses of a group one second, and the interval of undisturbed light between the groups of eclipses not less than eight seconds. I fixed upon the time one second because, after many trials of mechanisms to produce the eclipses, I found that I could produce all the groups of eclipses at the rate corresponding to one second for the short eclipse by a simple and inexpensive machine applicable to any lighthouse, large or small, and of any variety of optical arrangement, whether merely with condensation to the horizon, or with the additional appliances required to condense into a particular azimuth.

A machine fulfilling these conditions is now at work in the college tower of the University of Glasgow, performing the short-long-short of the following table for four hours every evening. It has been doing this for a month, and shows no signs of wear. Indeed, there is no part of the machine which is liable to wear in the course of years' regular service in a lighthouse. I refer to this machine at present, because it has been supposed that the plan of mechanism used in the Holywood Bank light, and Garvel Point, Craigmore, and Cardross lights, that is, a mechanism producing eclipses by revolving screens, and therefore applicable only to lights without azimuthal condensation, is the only mechanism which can practically produce the groups of eclipses at the speed necessary to carry out this method of giving characteristic qualities to fixed lights.

My proposal for giving character to fixed lights,

is at present definitely limited to the ten varieties shown in the following table. The short eclipse being one second, the long, three seconds, in every case, except the last; in the last case, the short eclipse is a half-second, and the long eclipse, three half-seconds:—

Number of eclipses in each group.	Description of the eclipse.	Time from beginning to end of each group of eclipses.	Period of time from beginning of one group to beginning of the next.
One	Long.	3 seconds	12 seconds
One	Short.	1 ,,	10 ,,
Two	Short-short.	3 ,,	12 ,,
Two	Short-long.	5 ,,	15 ,,
Two	Long-short.	5 ,,	15 ,,
Three	Short-short-short.	5 ,,	15 ,,
Three	Short-short-long.	7 ,,	20 ,,
Three	Short-long-short.	7 ,,	20 ,,
Three	Long-short-short.	7 ,,	20 ,,
Four*	Long-short-long-short.	11 ,,	20 ,,

It is obvious this plan may be understood immediately by any person learned or unlearned reading the description, or being told it by word of mouth, and that no knowledge of the Morse letters corresponding to the several groups of eclipses is needed. Indeed, if Mr. Preece and others had not let out the secret, I might have brought forward this proposal without any acknowledgment of indebtedness to Morse or to Captain Colomb, had I been disposed to omit to give credit where credit is due for very brilliant and valuable inventions, and had I thought only of the very best way of putting forward my little suggestion in the manner most likely to promote its early adoption by the lighthouse authorities.

I have only to add, in conclusion, that the highly important suggestion of Sir Richard Collinson, to use a high and a low note in direct contrast, to give characteristic sounds for lighthouses, may be worked out systematically in a very convenient manner by using the combinations of the preceding table; with a high note instead of the short eclipse, and a low note instead of the long eclipse; the low note of the same duration as the high note; the interval between the notes of each group about the same as the time of each blast; and the interval of silence between the group of blasts much longer than the whole time of each group. When the fog-syren is used, there is no difficulty in making the blasts as short as we please, and they certainly ought not to be longer than a half-second or three-quarters of a second. Quickness is here, as in many other nautical matters, of vital importance. Let anyone try for himself, sounding a high and a low note in rapid succession, or two high notes and a low, or any other of the combinations of the preceding table, and he cannot fail to be convinced there is in each case a characteristic sound, which needs no musical ear for its appreciation, and which cannot be misunderstood by anyone who has heard it, or has read it as the description of the sound of such and such a lighthouse, or has been told of it by word of mouth. The distinction between long and short blasts, as Mr. Price Edwards pointed out in his communication to the Society of Arts, already referred to, has not proved satisfactory in experience, and I believe this will generally be admitted to be the case by those who have experience of the working of the Morse system of long and short blasts of the steam-whistle or syren at sea. There is an uncertainty as to the instant when the sound ceases, prolonged as it often is by echoes, and in the case of the steam-whistle, an uncertainty also as to when it begins, which is very distressing to anyone trying to understand Morse-signals by long and short sounds. But corresponding signals by very short high and low notes following one another very quickly, with ample times of silence between the groups of sounds, are exceedingly clear, and may easily be distinguished, even when the sounds are barely audible.

* This characteristic is very easily read, and may be used with advantage in cases in which there is no practical difficulty in obtaining speeds corresponding to the times half-second and three half-seconds for the short and long eclipses.

DISCUSSION.

Dr. Tyndall, F.R.S., said there could be no doubt of the importance of the subject of the paper, to which he had listened with much pleasure, or of its growing importance, because the greater the number of lights there were, the greater was the liability to confusion between them. It was, therefore, a matter of growing necessity to be able to distinguish between lighthouses from other lights afloat and ashore. It might be imagined by any one who had been near to a lighthouse, especially if lighted with the electric light, that it could not possibly be mistaken for a floating light at a masthead; but he could assure them it was not only a possible, but an actual mistake; a candle in a lantern, placed in a certain position, was not to be distinguished by the sharpest eye from a distant electric light. Hence the necessity for the distinctiveness on which Sir William Thomson insisted. He (Dr. Tyndall) should himself lean to his view as to the utility of quickening the flashes, so as to bring them within the range of consciousness, and to present them without the labour of counting, or, at any rate, of looking at a watch. The Elder Brethren were by no means oblivious of the necessity for distinctiveness, and the beautiful apparatus devised by Dr. Hopkinson, for a triple or other flashing light—for he was not limited to the triple flash—and constructed in the workshops of Messrs. Chance, was obtained with the view of securing this object; and in a paper read by Mr. Douglass before the Institute of Civil Engineers, an elaborate scheme of signals was brought forward. He had been much interested in the experiments, which showed how easily gas lent itself to such purposes; and he might remark, that on the South Coast of Ireland there was a first-class lighthouse illuminated by gas. There a light of 300 jets of gas could be almost quenched and raised again in an instant by the simplest arrangement. With regard to the siren and sound signals generally, he might say that, at the present moment, the Elder Brethren were engaged in investigations. Sir Richard Collinson's proposal to use high and low-pitched notes in combination was of great value, and this would render the siren stations as distinct as he hoped the lighthouses soon would be. There was, therefore, a very healthy movement on the part of the Elder Brethren, which would be greatly promoted by the zealous efforts of Sir William Thomson, who brought his own individual experience to bear on it, who was fettered by no particular antecedents, but who had simply and solely at heart the welfare of the seafaring population.

Dr. Hopkinson, F.R.S., thanked Sir William Thomson for the kind way in which he had spoken of his

efforts to devise an apparatus for making distinctions, the importance of which he had so forcibly urged. He had put very clearly the advantages of flashing lights, by reference to the dynamic law that what was gained in power was lost in speed, which was strictly true. But, optically, the light you did not get when you did not see it, you did get concentrated in one flash when you did see it. With an ordinary light, giving a single flash of four seconds, with a period of half a minute, you got seven and a-half times as much light in that flash as you would with a fixed light burning the same quantity of oil. That advantage was very great, and could not even be made up by burning seven and a-half times as much oil, because, if you did that, you would have a larger source of light to deal with, which would throw greater difficulties in the way of the optical engineer. The greatest part of the diminution of light at a distance was due to absorption by the air, which was a larger cause of limitation than that due to the diffusion over a greater area, in proportion to the distance, so that if the weather were at all thick, the light might be reduced to 1-10th, 1-20th, or even 1-100th for every mile of distance, so that if you increased the power seven or eight times, you would not increase its range in the same ratio, particularly in thick weather. For all that, it was of vital importance to push the lights as far to sea as possible. With regard to the Royal Sovereign and Casquets, they were of a totally different character, so far as optical arrangements were concerned, the former being a floating light with catoptric apparatus, a series of reflectors with a flame in the focus of each; and with the construction of that light he had nothing to do. The Casquets was a dioptric light with a single flame in the focus. Sir William Thomson had urged that these large dioptric lights would be greatly improved if the revolutions were made much quicker, and he quite agreed with him, but in the case of the Casquets experiments had been carefully tried, at 15 seconds and 30 seconds, and he believed the opinion of those most experienced was that the half-minute light was the better. There was, however, a great difficulty in running these heavy lights at the speed suggested, not from any difficulty in making machinery strong enough to stand the wear and tear, but in getting the motive power; that could be only obtained from the sinews of the light-keepers, and his opinion was that at the Casquets those sinews were already taxed somewhat severely. Indeed, if ever a light-keeper were inclined to strike it would be at being called upon to make these heavy three ton apparatus revolve at a velocity which would give a triple flash every ten seconds. At the Bull Point, the labour had been somewhat reduced by improving the machinery. With regard to eclipsing lights, he did not think there would be any difficulty in having a reasonably rapid group of flashes, either with Sir William Thomson's machine, or with the one which had been for some little time in use in English lighthouses, and which had lately been introduced in China. These were first and second order lights, and the eclipsing screen, which was made of sheet iron, rose and fell something like two feet in some cases as rapidly as in half a second, which speed was quite sufficient to meet any ordinary requirements.

Captain Sir George Nares, K.C.B., F.R.S., said if seamen had not the "three F's," they had "three L's." Sir William Thomson had helped them to improve each. They were, the lead, the log, and the look-out. He had improved the lead; he had improved the log by improving the compass; and now he was trying his utmost to improve the lights and so help the look-out. But with these numerous distinctions they would have to educate the seamen, even the intelligent captain and his mate, to understand them. The Board of Trade were advancing very fast in the matter of examinations, and Sir William Thomson would do a great deal of good if he could induce the officials of the department to examine captains and mates in these matters. As a rule, they had not the slightest idea of any distinction between a flashing and an eclipsing light; they called them both revolving. Sir William Thomson dwelt on the letter S, and they were ready to accept that, and a single, double, or triple flash, or even four flashes, but he did not think he was yet sufficiently educated if he saw two lights, one on each side of him, one short and long, and the other long and short, to distinguish readily which was which. Sir William Thomson was working in the right direction, but they did not want to go too far. They had already seventy distinct characters of light on the coast, and that ought to be enough. Before going further, they ought to be well educated up to what they had already got.

Captain Ladd (of the Trinity House) said it must not be forgotten that a floating revolving light had three times the penetrating power of an occulting, or dot and dash light, and Mr. Hopkinson's light, as he had explained, had seven times the power. In other respects, he agreed with Sir George Nares.

Dr. Gladstone, F.R.S., desired to echo and emphasise all that had been said as to the importance of this subject. Many years ago it occurred to him that one of the most important improvements in this matter would be a distinction between lights; every lighthouse ought to be readily distinguished from lights on the shore, ships' lights, and so on, and to be distinct from its neighbours. Before coming to the meeting, he had referred to the report of the Royal Commission on lighthouses, of which he was a member, printed in 1861, and there he found it was laid down that no fixed lights should be placed on any important or prominent position, the reason being the evident one, that they were apt to be confounded with ships' lights, and with other lights on shore. There was also the reason that in a revolving light, as had been explained, the light was gathered up and concentrated, so that it carried a much greater distance. Last summer, when crossing from Swansea to Ilfracombe, he had much pleasure in seeing the Bull Point light arrayed with Dr. Hopkinson's apparatus; there was a distinction which anyone could see at once, the two short flashes with a longer interval of darkness following them, and on many successive days he watched it with great interest, and he also had the pleasure of examining the apparatus. In looking into the report which he had mentioned, he found what he had entirely forgotten, that a gentleman, who had recently become notorious in another line, the Rev. Pelham Dale, brought before the Commission a scheme for the distinction of lights identical in principl. with that now advocated by Sir William Thomsone He suggested that lights should have not more than ten distinctions; that they should give the Roman numerals by occultations; that a short occultation should represent the I., and a long one V.; so that if the number were IV., you would have one mark to represent the I., and another to represent the V. He also drew out a scheme for marking the various lighthouses in a similar way by daylight, by means of flags, and by suitable sounds in fogs. These distinctions ought certainly to be carried out all round the coast, and a very few would suffice. He did not altogether go with Sir William Thomson in what he took to be his preference for occulting lights over revolving, for it appeared to him that the former had two disadvantages. One was, that during the obscuration you lost a certain amount of light, which was not utilised, as it was in a revolving light; and, secondly, you could never have such a penetrating light. There was, of course, the argument, that what was lost in one direction was gained in another; but it seemed to him that for prominent points on the coast it was advisable to have a revolving light like that on the Casquets or Bull Point, which should be more rapid in action than they generally

were. In other places, where it was not necessary that the light should carry so far, the occulting light might be used with advantage.

Mr. Liggins said he remembered the two terrible wrecks which occurred 40 or 50 years ago between Boulogne and Cape Grisnez, of the *Reliance* and the *Conqueror*, involving an immense loss of life, which were caused by these ships mistaking the Grisnez light for Dungeness. From that time, the authorities of both countries had done their best to make the lights so distinct that such an accident should not occur again; but yet, during the last winter, three ships had been wrecked near Boulogne from the same cause. It was all very well to watch the experiments in that room, but it was a very different thing to distinguish the flashes on a dark winter's night in a storm. He, for one, did not think they would be distinguished by the most intelligent captain in the Royal Navy, or the captain of the finest steamer. The captains of colliers did not care about them; they took care not to pass any light until they knew what it was. The difficulty was with the captains of fruit schooners coming from the Azores, racing up to London with a cargo, who wanted to know what light it was they first came upon in the English Channel, when perhaps they were not quite correct either in their latitude or longitude. He should hail with satisfaction any practical plan which would enable the sailor to do so, but he thought the present system was far superior to the one now proposed. He quoted from a description by Mr. Brassey, of his run across the Bay of Biscay, with a fine ship and a picked crew, to show that it was possible to mistake a white masthead light for a green light; and he had himself often found it impossible, on coming into the English Channel, to see any light at all. In summer time and fine weather he could distinguish perfectly the four lights on the Goodwins from his window, at Ramsgate, but in winter time, very often he could not see them at all.

Mr. W. H. Preece said if he had been imprudent in his utterances, as Sir William Thomson suggested, how much more imprudent had he been himself, who was the first to suggest to him at the meeting of the British Association at Brighton, that the proper system for lighthouses was to adopt the Morse alphabet. It might be the dream of a telegraphist, but he who had been nearly all his life reading signals by dots and dashes, high notes and low notes, and other figures of the kind, would not have the slightest difficulty in reading off by these flashes of gas-light a lecture delivered by Sir William Thomson, and he looked forward to the day when the lighthouses round the coast should shout out not in audible, but in visible language, to every nation on earth its name and position. If it was a dream, it was certainly within the reach of practical engineering, and gradually, but surely, the Trinity Board, and the Board of Trade, were attaining the necessary education, in which they were immensely helped by the persistent efforts of reformers like Sir William Thomson. But whilst they were being educated up to the Morse alphabet, Sir William Thomson seemed to be running away from it, so as, in many other cases, it might be said that extremes met, and so it would go on until they had their lights established on a principle that he who ran might read. A flashing system no more needed counting, than the words Trinity House needed spelling. If those words were written up in large characters, the whole group would convey the idea of Trinity House at one glance; and so, whether you called it the Morse alphabet, or the flashing system, or the grouping system, if you simply applied a system by which the eye was enabled to grasp at one view the position or name of the lights, you attained exactly the same result as if you printed the word. That was the principle Sir William Thomson was advocating, and he hoped he would continue writing papers and pressing forward the subject until the Trinity House adopted a sensible system.

Dr. C. W. Siemens, F.R.S., said the subject was one of great interest to him, but he had not given sufficient attention to the details to be able to speak with any authority upon it. He might say a word or two, however, on the probability of seeing the electric light established for the purpose of giving those flashes which had been referred to. He might certainly say that the electric light appeared destined to take the place of all other lights for that purpose. In dealing with light produced by the combustion of oil or gas, they were necessarily limited to the amount to be obtained under given conditions. A large amount of light could be obtained by combustion, but it could not be concentrated within the focus of a lamp. It was only by the electric current that small surfaces could be heated to a point far exceeding the temperature attainable by combustion, and send out rays of light second in energy only to those of the sun. It had been proved by St. Clair Deville, and Bunsen, that the utmost temperature to be obtained by combustion was about 2,400°, when a point was reached at which combustion ceased and dissociation set in; and therefore it was impossible to obtain rays of high intensity by means of combustion. There were, no doubt, practical difficulties to be overcome in applying the electric light to some situations where power could not be easily raised; but means of producing power were continually being improved. Where you could not raise steam you could decompose oil; and where you could not work a steam-engine you could a gas-engine or an oil-engine, as was already done in the United States to a large extent. With the electric light also an admirable system of flashes of any desired rapidity could be attained; and he would conclude by expressing a hope that they would soon attain the desired point when each lighthouse would not only tell its own tale, but also give that information to the greatest possible distance.

The Chairman said it must be borne in mind that, in listening to this paper, they were not listening to a mere scientific man, unacquainted with the practical details of seamanship, for there was no more ardent yachtsman than Sir William Thomson in all England; and they would all remember the way in which he indignantly repudiated the idea that the man who, in the midst of storm and tempest, could navigate a vessel along the shores of England, from Newcastle to London, with a cargo of coals, was not a man of intelligence, or that he could not do as much it was said a crow could do, viz., count four. Sir William Thomson had already given to navigation a sounding implement and a compass, now very largely used, and he was the apostle of this doctrine of the identification of lighthouses, the necessity for which was so apparent that it was not necessary to take up time by dwelling upon it. It was better to be without a light at all, than to have one which was misleading; and it was to prevent this misleading, which became more and more likely every day, having regard to the fact that a white light, in a lighthouse at a distance, could readily be mistaken for another white light in the immediate neighbourhood, that this system was devised. Sir William Thomson, by his persistence in this matter, was doing infinite good, and was likely to save many lives which were now lost in consequence of the mistakes made in distinguishing one light from another. A supposed quotation from the Bible had been made more than once, and, as usual, it was misquoted. They had been told of a light, "which he who runs may read," whereas it should be "that he may run who readeth;" in other words, that what was read should be of such a terrible character, that he who saw it ran away from it.

Sir William Thomson, in reply, said he would first

read an extract from a letter which had been put into his hands since the discussion commenced. It was from Mr. J. R. Wigham, of Dublin, one of the great improvers in gas appliances for lighthouse purposes; and he said:—"Knowing a little of the efforts which are being made by the Irish Lights Board and their scientific adviser, Dr. Tyndall, in the direction of the plan you advocate, I thought I would mention that they have at last obtained the consent of the Board of Trade, to fix a group flashing gas-light at Copeland Island." With regard to Dr. Hopkinson's statement as to the possibility of giving the rapidity he desired to a triple-grouped flashing light, he could only say that the difficulty he had mentioned was no doubt real, and he did not wish to have anything very extravagant attempted; if it were to be a severe tax on the light-keeper to make the Casquets light much quicker, he should prefer leaving it as it was. He only wished to keep rapidity in view, in all cases in which it can be attained; and although it was said that double speed was not so good as that adopted, it did not follow that that quadruple speed would not be much better. They might look forward to much greater speed with the electric light, with its extreme pliability in respect of stopping and starting. The electric light on the tower of Glasgow University, during the exhibition of gas and electricity, in October last, constructed by Messrs. Latimer Clarke and Muirhead, gave identifying occultations, long and short, in the most admirably perfect manner, by extemporised mechanism, and worked with all the quickness desired. Sir George Nares spoke of 70 distinctions of lights, but what he had brought forward was a plan for simplification. Instead of 70 distiuctions of an unsystematic character, he proposed to have only two classes, flashing and occulting, each divided into nine varieties. He certainly should not like to have to distinguish between a long and short on his right hand, and a short and long on his left, but wherever there were two lights near each other, on the two sides of a channel for instance, the difference should be made as marked as possible. The Chairman had used an admirable expression in speaking of the identification of lights; that was what he wanted, that each light should identify itself. He did not approve of either numbers or letters being associated with the signals, but preferred long-short, long-short-short, and so on; still more did he object to anything like spelling names, which he had been most mistakenly accused of recommending. He had even been accused by a scientific expert, in a lecture, of having proposed to the Clyde Navigation to spell out C.U.M.B.R.A.E., though in the very building in which the lecture was given he had specimens of lights giving identifying signals such as he described. With regard to the question of the flashing and fixed light, as stated by Dr. Gladstone, he preferred the fixed light, and the character given by the occultations for the reasons he had stated, but he had endeavoured to weigh, as fairly as possible, the respective advantages, on the one hand of never losing sight of the light, and on the other the greater brilliancy. Dr. Hopkinson had pointed out why, even by increasing the consumption of oil, the fixed light could not reach the brilliancy of the flashing light, except by gigantic optical appliances; but even assuming all new lights were of the flashing order, there were 400 fixed lights, and what was to be done with them? The experience of Mr. Brassey, as quoted by Mr. Liggins, proved conclusively that a white light might be mistaken for a green one, which showed how necessary it was to have some better means of identification. Lastly, he wished to say that he had not quoted from the Bible at all, but from the Trinity Brethren.

The **Chairman** then proposed a cordial vote of thanks to Sir William Thomson, which was carried unanimously, and the proceedings terminated.

MISCELLANEOUS.

SILK-PRODUCING BOMBYCES REARED IN 1880.

By Alfred Wailly

(Membre-Lauréat de la Société d'Acclimatation de France).

(*Continued from page* 285.)

Telea Polyphemus (North America).—This silkworm, which produces a closed cocoon, a little smaller than that of *Pernyi*, is the best of the silk pruducers of the United States of America. The silk is white, very fine, and seems to be of a very superior quality. It can easily be bred like *Pernyi* in the open air, in England, unless the weather should be exceptionally bad. *Polyphemus* is now acclimatised in Spain, where I introduced it in 1879. In 1880, some 1,500 wild cocoons were collected from oak, birch, and other trees. It is very polyphagous. My Spanish correspondent considers *Polyphemus* as a valuable acquisition to sericiculture in Spain, but he says it has a tendency to become double-brooded there, two male moths having emerged in November. The larvæ thrived well on birch (*Betula alba*). My correspondent in Alabama, from whom I have just received some *Polyphemus* cocoons, which are very small, and covered with leaves of a species of ever-green oak, says it is double-brooded in Alabama, as it must be in all the Southern States of America; in the Northern States it is single-brooded.

Samia Gloveri.—In 1880, I received a large number of cocoons of this North American bombyx. They were collected, my correspondent wrote to me, some 40 miles south of Salt Lake City, Utah, in a locality which had never been previously explored. As far as I have been informed, this fine species, up to the present, has only been found in Utah and Arizona. The cocoons were collected in plantations of a species of willow with small narrow leaves. The cocoon, somewhat similar but smaller than that of *Samia cecropia*, is generally of a silvery grey outside; the rough envelope adheres to the cocoon inside, which is of a very dark brown. The *Gloveri* moths emerged from the middle of April to the middle of July, but no pairings could be obtained.

Samia Ceanothi.—This species, a little smaller than *Gloveri*, is a native of California. The moths do not vary in shades of colours like *Cecropia* and *Gloveri*; the ground colour of the wings is of an uniform reddish brown; the bands and markings are pure white. *Gloveri* partakes of *Ceanothi* and *Cecropia*, as if it were a cross between these two species.

The cocoon of *Ceanothi* is very different from that of *Gloveri* or *Cecropia*; it has the open end very pointed, and is pear-shaped; its colour is iron-grey. The inside cocoon is brown, and small, compared to the outside envelope.

The moths of *Ceanothi* (of which I had reserved 40 cocoons) emerged from the 3rd of April to the 18th of July; a perfect specimen had emerged in March. Two pairings only were obtained. The larvæ bred on plum and willow did not thrive, and died in first and second stage, a few going into third stage. From a letter recently received from one of my German correspondents, Herr H. Wolff, of Breslau, I hear that three cocoons were obtained by this entomologist with only six eggs at his disposal, a very great success, considering that failure has attended the efforts of several others in the rearing of this species.

The first pairing of the *Ceanothi* moths took place on the 27th of June, the second on the 10th of July. The ova of the first brood hatched 18 days, and those of the second, 15 days after having been deposited.

The larvæ, somewhat similar to those of *Cecropia* in the first and second stage, but of a lighter colour, showed a marked difference in the third stage, and

were thus:—Back of body, sky-blue; sides, greenish yellow; tubercles, golden yellow all along the back, and on the sides, blue; head green.

Hybrids.—Although *Samia gloveri* moths refused to pair among themselves, I had several crossings between *Gloveri*, *Ceanothi*, and *Cecropia*. The ova obtained from a long pairing between a *Ceanothi* female and a *Gloveri* male were the only ones which were fertile. Unfortunately the larvæ, reared on willow and plum, all died, some reaching, like *Ceanothi*, the third stage. The pairing of *Ceanothi* and *Gloveri* was from the evening of the 20th to the evening of the 21st of May. The larvæ hatched from the 15th to the 21st of June, the majority having hatched on the 16th and 17th of June. All the ova hatched, excepting a few; over 200 in all. First stage—Larger larvæ, black; smaller ones, buff, the colours becoming of a more uniform hue as the larvæ increased in size. They were very much like *Cecropia* larvæ. Second stage — Larvæ, yellow, with black tubercles; head, black. Third stage—Back, bluish; sides, yellow; tubercles on back, orange-red; tubercles on sides, blue; head, yellow.

Eight larvæ, the produce of a pairing of female *Saturnia pyri* with unknown *Samia* (the pairing was not seen), lived seven days on plum; they were bright yellow, with a dark ring round each segment.

The other crossings resulting from the keeping of various species together in large cages, when male and female moths of the same species could not be obtained simultaneously, are the following:—In a hot-house, at a gardener's, on the 22nd of May, *Telea polyhemus* (female) with *Attacus mylitta* (male), of the Bombay race; *T. polyphemus* (female) with *Attacus pernyi* (male); *Samia gloveri* (female) with *Pernyi* (male). In my house, at ordinary temperature, on the 12th and 13th June, *Samia ceanothi* (female) and *S. cecropia* (male); on 15th June, *S. gloveri* (female) with *S. cecropia* (male); on the 18th and 19th June, *S. cecropia* (female) with *S. ceanothi* (male). In all the above cases, the ova were unfertile.

The difficulties I have experienced to obtain living cocoons from India and other distant countries, induced me last October to write an article on the collecting and rearing of larvæ, and on the best plan to be adopted for the sending of cocoons and pupæ, so that they should arrive in England in good condition. This article was sent to India, China, and South Africa. It appeared in the *North-China Herald*, of November 25th, 1880, and in the *Madras Athenæum* and *Daily News*, of Saturday, December 4th, 1880. It was sent also to correspondents for insertion in the *Times of India* (Bombay), the *Calcutta Englishman's Overland Mail* and the *Cape Argus*.*

Persons residing abroad, who may be willing to collect and rear larvæ of *Lepidoptera*, will find this a most interesting and instructive study. It is within the reach of all, and is at the same time profitable, as the pupæ and cocoons obtained would be purchased from them by other collectors. Larvæ can be found in almost unlimited numbers by using a sweeping-net over low plants, or in beating bushes, shrubs, and trees, placing an umbrella under the branches to receive them. Larvæ which hide themselves in the day time can only be found in large numbers by looking for them at night with a lantern.

The rearing of the caterpillars, after a little experience, will be found extremely easy. Some will require to be placed in cages, when active and apt to run away; others, like the silk producing Bombyces, may be reared uncovered on branches plunged into water, care being taken to use long branches (never small twigs) when the larvæ are large. When very small branches are used, the foliage becomes too watery, and it may cause the death of the larvæ. Cut leaves have to be renewed too often, and therefore should be avoided, to feed the larvæ whenever cut branches plunged in water can be used. Branches should also be cut in the evening or early in the morning, and not in the daytime when the sun is hot, as, in the latter case, the foliage would soon be faded. When trees in pots can be used to feed the larvæ, the rearing is, of course, more simple, and there is a saving of time. Another plan, which is the best to rear larvæ forming cocoons in the leaves or on the branches, is to place them on the living tree in the open air, taking care to protect them from birds.

To give fresh food to larvæ reared on cut branches kept in water, when the foliage has been eaten, or is too old and dry, is very easy. The old branches are merely placed in contact with fresh branches, or the old branches cut in pieces (not to be too heavy) are placed on the new ones. The larvæ, which should not be handled, will leave the old branches to go to the fresh ones. In a short time the old branches, bare of larvæ, may be removed.

When branches are plunged in a bottle, or any other vessel containing water, the foliage at the base of the branch should be cut off, as leaves in the water would decompose it, render the rest of the foliage unwholesome, and even poison the larvæ. The cut branches in water should be placed in the shade, where they will keep fresh for several days, especially if the foliage is sound and healthy, a condition of great importance. The water should be renewed, and the foliage freed of green flies and other small insects.

To rear *Lepidoptera* from the egg the moths should be placed in cages for pairing and depositing their eggs. With moths of *Sphingidæ* and some other species, it is useful to put in the cage a bunch of aromatic flowers, with branches of the plant the larvæ feed upon. Moisture should always be maintained in the cages.

A few days, or immediately after the eggs have been obtained, they should be placed under a glass with a small branch or leaves of the proper plants, so that the larvæ should find their food as soon as they are hatched.

When the larvæ are small, I rear them under bell-glasses, having a few holes on the dome. These glasses, which are of various sizes, according to the number of larvæ, rest on saucers full of sand covered with a piece of paper. Small branches of the proper food plants are struck through the paper and plunged into the sand, where they keep fresh for several days without requiring any water.

The larvæ, under a bell-glass, can be watched and kept perfectly clean, for, after having removed the glass, it is sufficient to blow on the paper to remove all the dejections. Some larvæ may thus be reared till they turn into pupa state, under glasses one foot high and one foot in diameter, or larger, according to the size of the larvæ. With larvæ of the large silk-producing and other Bombyces, after the first or second moult, when they have ceased to wander, it is best to rear these without the glass covering; branches plunged in water are then used, as mentioned before. The larvæ should be reared in the open air, but sufficiently protected, or in a well ventilated room. Larvæ which go into the ground to turn into the pupa state should be reared in cages containing a few inches of light soil or soft sand, and this plan must always be adopted when the habit of the larvæ is not known.

Now, with respect to the sending of living cocoons and pupæ from abroad, on the cases there should be written in large letters, "living pupæ," or "living cocoons of silkworms," with request to keep the cases in the coolest place, or in the ice-house of the vessel. The cocoons should be well packed in straw, hay, moss, or anything that will deaden the shocks to which the cases may be subjected. Pupæ of lepidoptera must be placed in bran, sawdust, or fine moss. Cocoons and pupæ should be sent as soon as possible after their formation, from the beginning of October to about the beginning of April, according to distance, so that they should not be subjected to the heat the whole of the time during their voyage to England. Small quan-

* From a letter just received from Major G. Coussmaker, I hear that the article appeared in the *Times of India*, and also in the *Indian Agriculturist*.

tities of cocoons and pupæ should be sent by sample post, in registered boxes, not exceeding the legal weight; the boxes must be strong, and it is best to tie a label to each box, and affix the stamps to the label. Persons living too far inland to send living pupæ may send dead specimens of the perfect insects (butterflies and moths). These should be in good condition, and placed with folded wings in paper envelopes. To protect these specimens from the attacks of mites, "Dermestes" beetles, and other parasites, it is important to put some poison in the boxes containing the specimens.

With respect to the sending of live cocoons and pupæ, and even ova of lepidoptera, I may say, that with a little care, and especially if they were given in charge of the captain, or some other person on board ship, they could be sent to Europe from distant countries, and arrive alive, and in good condition.

In proof of this, I may mention the fact, that Mr. Youl, acting as agent of the Tasmanian Government, shipped in 1864, packed in a box, which was placed in the ice-house of the steamer *Norfolk*, a large quantity of salmon and trout ova, the result being the successful introduction of salmon and trout into the rivers of Tasmania and Australia.

In the same way, silkworm ova, live cocoons, and pupæ could safely be sent to Europe, from very distant countries, and this would be of the greatest interest and value to entomologists, for the study of lepidoptera in their various states.

To conclude, I shall reproduce the letter of one of my correspondents, Mr. J. P. Cock, whose death I accidentally learnt, on the 18th November last, in a house at Thames Ditton, from Mr. P. Clarke, a gentleman who is a tea-planter in Assam. This sad news was recorded in an Indian paper, the *Assam Gazette*, of October 25, 1880, which, at my request, was forwarded to me a few days after.

I now give my correspondent's letter to me, dated 14th February, 1880, and received on the 12th of March, 1880:—

"Kassia Hills, Assam.

"Dear Sir,—You must have thought it very remiss on my part, allowing your letter to remain so long unanswered, but a sudden and unforeseen calamity, in the death of my only brother, Major Cock, Deputy-Assistant Adjutant-General, Eastern Counties Districts, who fell mortally wounded while leading on his men in the final assault on Khonoma, in the Naga Hills, has entirely prevented me paying any attention to entomological pursuits for the last three months.

"My poor brother having died possessed of a good deal of landed property in no less than three of our Indian hill stations, I have been travelling incessantly winding-up his affairs; in fact, I may with perfect truth say, that for the last two months and a-half, I have been living in railway carriages and on board river steamers.

"The old adage, that misfortunes rarely come singly, I have found in my case to be true, for on my return to this station last Thursday, I found that my bungalow had been burnt to the ground through the gross carelessness of a drunken syce. Nothing was saved, a magnificent and most expensive library of entomological works, 47 large cabinets of specimens (my own private collections), my gleanings for over 26 years in Sumatra, Java, New Guinea, Borneo, Calebes, the Phillipine Islands, and Japan, over 4,000 specimens ready to forward to England, all was lost just through the carelessness of a drunken wretch capsising a lamp in my stables.

"I keep up a staff of eight Rhapias, whom I have thoroughly trained for the work of collecting in the malarious jungles, where it is almost certain death for an European to sleep one night. I likewise have a large circle of friends and acquaintances among the officers and tea planters in the districts, all of whom I have persuaded to collect for me, and who send me monthly what they have been able to accumulate, and as I always take the field myself in March, and do not generally leave the forests before autumn is far advanced, many thousand insects pass through my hands annually.

"As before stated, all my large stock of reserved insects has been lost in the fire; however, I hope in the course of a month, or six weeks at the latest, to be able to dispatch you a first consignment. I will pay particular attention to your wishes about the cocoons of our various silk moths, and have already received letters from two intimate friends who, perhaps, are two of the most eminent entomologists in India, Capt. Marshall and Col. Jones, both officers in the Royal Engineers. They inform me that they have written to some of their correspondents in other parts of the Himalayas to procure cocoons of such of the silk moths as are not procurable here. I can, however, promise to send you any number of cocoons of the following secies:—*Attacus assamensis*, *Attacus atlas*, *Actias selene*, and *Actias mœnas*. Will you kindly write to me by first mail after the receipt of this, what cocoons do you consider most valuable, and the particulars that may be useful to me in forwarding them.

"I shall probably be away in the wilds of the Naga hill forests, but your letter will be forwarded on without delay. I should very much like to see some of your reports, it would give me very much pleasure to read them, and in return, will forward you a copy of my book on the genus *Deilephila*, which ought to be completed and published next month. It includes all the known Asiatic species of *Cherocampa*, *Sphinx*, *Macrosila*, *Smerinthus*, and the illustrations, over 400 in number, have taken me nearly three years to complete, as I have drawn each moth in water-colours as soon after capture as possible, with representations of the egg, caterpillar, and tree on which they live.

"As the season is not sufficiently advanced to take the field, hard frosts and bitterly cold winds prevailing at this lofty elevation where anything in the shape of vegetation is parched and dried up, I am, at present, hard at work on the illustrations for a work of Captain Marshall's, on "Our Indian Lepidoptera;" when completed it will be the most perfect work on Asiatic lepidoptera ever given to the world, over 2,000 specimens illustrated.

"About a dozen of us are starting a new monthly entomological magazine; how it will answer I cannot tell; fortunately, all men concerned in it are tolerably well off, so, if it fails, we shall none of us be ruined.

"Hoping to hear from you in reply to this, giving me all the information in your power about the cocoons, I remain, &c."

After the receipt of this letter, to which I replied three times, I never received any communication from my correspondent, and, as above stated, it was by mere accident that I heard of his death.

Alfred Wailly.

110, Clapham-road, London, S.W.

CORRESPONDENCE.

THE PARTICIPATION OF LABOUR IN THE PROFITS OF ENTERPRISE.

If it is not out of order, before the close of the discussion upon this important subject, which I shall have no opportunity of attending, I should like to offer a few suggestions upon a question which I have had peculiar advantages of studying, from both an official and employer's point of view.

That there is a great amount of wasted and misplaced energy existing among workmen scarcely admits

of argument; and it has always appeared to me, that the greater part of it arises from the want of personal interest in the quantity or quality of work done; where quantity is the only object to be gained, piece-work seems to meet every requirement in this direction, the prices being regulated by the natural law of supply and demand, while bringing the best man to the front; but where quality is required, piece-work as a rule becomes a failure, and some scheme of participation in profits is the only reasonable solution of the problem.

I submit that any scheme of this kind will prove useless, if it fails to recognise the following conditions, viz.:—That the margin between a workman's earnings and his daily requirements is too small to admit of its being risked to meet trade losses, even supposing workmen could be found willing to incur such a risk; and that forced investment will never be popular among the bulk of British workmen.

To comply with these conditions, the following principle seems to me to be the correct one upon which to base any scheme of participation, and I feel sure would be found acceptable to a large number of our masters and men—viz., that if a workman, by dint of increased exertion, can supplement the ordinary profits of trade, he is justly entitled to one half of the amount so earned, but bound to leave the other half in the hands of his employer, to cover the risk of loss, for which he has no capital provided. In the case of old and well-established concerns, this standard of ordinary profit might be fairly arrived at, by taking the average of the profit and loss balance for a number of years, extending over a period of both inflation and depression of trade; and with new concerns, by a fixed percentage, covering interest upon capital invested, and a reasonable profit. But, in all cases, the amount divisible among the workmen to be paid to them annually in cash, upon their production of a qualifying certificate of a certain maximum of service, based upon a system of tickets given over with their wages.

The employer, in the face of continued losses, would have the option, as now, either of reducing the workman's wages, or of closing his business altogether; whilst the payment of a yearly bonus—in some cases probably being a much larger amount than the workman was in the habit of receiving at one time—would lay the foundation of habits of thrift, otherwise unthought of for want of encouragement.

The well-known antipathy of trades unions to piece-work has, in my opinion, done more to estrange the good feeling which should exist between capital and labour than anything else, and probably has stifled, at the same time, many comprehensive schemes on the part of the employers for mutual benefit.

J. B. Squire.

Worston-house, Durning-road, Liverpool.
February 22nd, 1881.

RIVER CONSERVANCY BILLS.

You did me the honour last week to print an abstract of the remarks I made on Mr. Cresswell's paper. They are generally very accurate, but there are two points upon which I appear to have been misunderstood by your reporter.

1st. I am made to say that I think the classification of lands should take place before the formation of districts, whereas the exact opposite is my opinion.

The district and its authority should be formed first, and afterwards, when Government sanction is sought for any particular works a Board may wish to carry out, will be the proper time for the Local Government Board, with the aid of its inspector, to go into the question of how far different lands will be benefited. It must be remembered that what any works are worth to a landowner must depend upon the character and position of those works; and what proportion he ought to pay should be settled when the works have been decided upon, and when their locality and probable effect have been announced.

If all the owners in a watershed have, before a Board can be formed, to submit to being taxed in a certain manner for river improvements still undevised in localities still unfixed, you may depend upon it more fighting than flood prevention will be the result.

2nd. I am made to say that if weirs were removed from rivers, "it would not make any difference in the level of the water." What I did say was to this effect, that there are many weirs on the Thames up which boats can be rowed during extreme floods, and that the fall at the weir, which, in such cases, must be extremely small, is an outside measure of the improvement that could result from the removal of the weirs.

R. W. Peregrinne Birch.

2, Westminster Chambers, Victoria-street, S.W.
March 2nd, 1881.

OBITUARY.

William Arnot, F.C.S.—Mr. Arnot, a consulting chemist and chemical engineer, of Edinburgh, died on the 9th February, at the early age of 38, at Bridge of Allan, to which place he had gone for change of air. Although his health had been broken by a severe attack of rheumatic fever last winter, his death was somewhat sudden, and he was announced to read a paper before the Society of Arts, on the 9th of the present month, on "Improvements in the Treatment of Esparto for the Manufacture of Paper," a subject to which he had paid special attention. In the winter of 1877, he delivered a course of six Cantor lectures, on "The Technology of the Paper Trade." Mr. Arnot was born in Falkirk, where his father was an ironmonger, and in early life he removed to Glasgow to study chemistry under Dr. Penny. He was subsequently appointed chemist to Messrs. Macfie's Sugar Refinery, but, in 1868, he returned to Scotland to assist Dr. Penny in the work of purifying the River North Esk, and shortly afterwards, on the doctor's death, he was appointed successor. In 1873, he opened large chemical works at Kirkintilloch. This undertaking not being successful, he removed to Edinburgh. Mr. Arnot elected a member of the Society of Arts in 1877.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

March 9.—"Ascents of Chimborazo and Cotopaxi, in 1880." By Edward Whymper.

*** Members are requested to take notice that this meeting will be held at the South Kensington Museum. For conditions of admission see page 289.

March 16.—"The Compound Air-Engine." By Col. F. Beaumont, R.E.

March 23.—"The Increasing Number of Deaths from Explosions, with an Examination of the Causes." By Cornelius Walford.

March 30.—"Recent Advances in Electric Lighting." By W. H. Preece.

April 6.—"The Discrimination and Artistic Use of Precious Stones." By Professor A. H. Church, F.C.S.

April 27.—"Five Years' Experience of the Working of the Trade Marks' Registration Acts." By Edmund Johnson.

Dates not yet fixed:—

"The Manufacture of Glass for Decorative Purposes." By H. J. Powell (Whitefriars Glass Works).

"Buying and Selling; its Nature and its Tools." By Professor Bonamy Price, M.A. Lord Alfred S. Churchill will preside.

"The Electrical Railway, and the Transmission of Power by Electricity." By Alexander Siemens.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

March 15.—"Diamond Fields of South Africa." By R. W. Murray.

April 5.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

March 24.—"The Future Development of Electrical Appliances." By Prof. John Perry.

The meeting previously announced for April 7 will be held on May 12.

Indian Section.

Friday evenings, at eight o'clock:—

March 4.—"The Results of British Rule in India." By J. M. Maclean. Sir Richard Temple, Bart., G.C.S.I., C.I.E., D.C.L., will preside.

March 25.—"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

Syllabus of the Course.

Lecture I.—March 7.

The production and regulation of electric currents. The laws of the mutual induction of currents and magnets.

Lecture II.—March 14.

The measurement of electric currents. Efficiency of magneto- and dynamo-electric machines. Heating effects of the current.

Lecture III.—March 21.

Use of magneto- and dynamo-electric machines for electric lighting. Electric lighting by means of the arc.

Lecture IV.—March 28.

Subdivisions of the electric current. Incandescent lamps. Luminous effects of electric currents in a vacuum, and in various gases.

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Three Lectures.

April 25; May 2, 9.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

May 16, 23, 30.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 7th...**SOCIETY OF ARTS,** John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Professor W. G. Adams, "The Scientific Principles Involved in Electric Lighting." (Lecture I.)
Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. T. Aveling, "Tithes, Ordinary and Extraordinary."
Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. H. H. Collins, "Sanitation as an important increment of value in House-Property."
Society of Engineers, 6, Westminster-chambers, 7½ p.m.
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Mr. R. Brown, "Language and the Theories of its Origin."
London Institution, Finsbury-circus, E.C., 5 p.m. Rev. Prof. A. H. Sayce, "The Gods of Canaan."

Tuesday, March 8th...Medical, 11, Chandos-street, W., 8½ p.m. Anniversary.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. A. Schäfer, "The Blood." (Lecture VIII.)
Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on Sir William Thomson's paper, "Tide-Gauge, Tidal Harmonic Analyser, and Tide-Predicter."
Photographic, 5a, Pall-mall East, S.W., 8 p.m. Paper by Mr. Payne Jennings.
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Exhibition of rubbings taken from door-posts and window-frames in New Zealand. With a note from Prof. Max Müller. 2. Mr. S. E. Peal, "Note on Assam Dwellings." 3. Major R. G. Woodthorpe, "A short account of the Wild Tribes inhabiting the so-called Naga Hills, on our North-Eastern Frontier of India."
Royal Horticultural, South Kensington, S.W., 1 p.m.

Wednesday, March 9th...**SOCIETY OF ARTS** (in the Theatre of the South Kensington Museum), 8 p.m. Mr. Edward Whymper, "Ascents of Chimborazo and Cotopaxi, in 1880."
Geological, Burlington-house, W., 8 p.m. 1. Prof. R. Owen, "Description of Parts of the Skeleton of an Anomodont Reptile (*Platypodosaurus robustus*, Ow.), Part 2. The Pelvis." 2. Prof. R. Owen, "The Order *Theriodontia*, with a Description of a New Genus and Species (*Ælurosaurus felinus*, Ow.)." 3. Mr. G. M. Dawson, "Additional Observations on the Superficial Geology of British Columbia and Adjacent Regions."
Graphic, University College, W.C., 8 p.m.
Microscopical, King's College, W.C., 8 p.m. Mr. A. D. Michael, "A Species of Acarus Believed to be Unrecorded."
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m. Annual Meeting.
Sanitary Institute of Great Britain, 9, Conduit-street, W., 8 p.m. Adjourned Discussion upon Mr. W. H. Michael's paper, "The Law in Relation to Sanitary Progress."
Royal United Service Institution, Whitehall-yard, 8½ p.m. Lieut.-Col. E. F. Chapman, "The March from Kabul to Kandahar in August, 1879, and the Battle of the 1st September."

Thursday, March 10th...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. W. Morris, "The Prospects of Architecture in Modern Civilisation."
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Walter J. Allen, "Art with reference to the Stage." The Sequel.
Royal Institution, Albemarle-street, W., 3 p.m. Rev. W. Houghton, "The Picture Origin of the Cuneiform Characters." (Lecture II.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.

Friday, March 11th...Royal United Service Institution, Whitehall-yard, 3 p.m. Vice-Admiral W. M. Dowell, "Naval Tactics."
Royal Institution, Albemarle-street, W., 9 p.m. Prof. J. Stuart Blackie, "The Language and Literature of the Scottish Highlands."
Astronomical, Burlington-house, W., 8 p.m.
Geologists' Association, University College, W.C., 2½ p.m. Visit to the British Museum, under the direction of Mr. Stuart V. Ridley.
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street W., 8½ p.m.
New Shakespeare, University College, W.C., 8 p.m. 1. Dr. Brinsley Nicholson, "The 'Tempest' founded on an older Play." 9. Mr. Herbert A. Evans, "The Quartos of 1 and 2 'Henry IV.'"
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lecture.) Dr. Coupland, "Anæmia." (Lecture I.)
Folk Lore Society, 22, Albemarle-street, W., 8 p.m. Rev. J. Sibree, jun., "The Oratory, Songs, Legends, and Folk Tales of the Malagasy."

Saturday, March 12th...Ladies' Sanitary Association (at the House of the Society of Arts), 5½ p.m. Dr. B. W. Richardson, "Domestic Sanitation or Health at Home." (Lecture V.)
Physical, Science Schools, South Kensington, S.W., 3 p.m. Col. Festing and Capt. Abney, "The Absorption Spectre of Organic Bodies."
Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. Stuart Poole, "Ancient Egypt in its Comparative Relations." (Lecture IV.)

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FRIDAY, MARCH 11, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the third course was delivered on Monday, 7th inst., by Professor W. G. Adams, F.R.S., on "The Scientific Principles involved in Electric Lighting." The lecturer commenced with a description of the production and regulation of electric currents, and then illustrated the laws of the mutual induction of currents and magnets. Arrangements have been made for the exhibition of various incandescent and other lamps in action at the third and fourth lectures, and for this purpose the British Electric Light Company have kindly promised to lend Gramme machines, and Messrs. Robey to lend a steam-engine to drive the machines.

The lectures will be published during the summer vacation.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1881, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially, by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1873, to C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B, F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy, and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious manual labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal services rendered to Arts, Manufactures, and Commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

The Council invite members of the Society to forward to the Secretary, on or before the 23rd of April, the names of such men of high distinction as they may think worthy of this honour.

COMMITTEE ON PREVENTION OF STREET ACCIDENTS.

A meeting of the Committee appointed by the Council to confer with a deputation from the Society for Preventing Street Accidents, was held on Monday, March 7, at the House of the Society of Arts. Present:—Sir Rutherford Alcock, K.C.B., Mr. G. C. T. Bartley, Mr. Andrew Cassels, and Sir Henry Cole, K.C.B., with Mr. H. Trueman Wood, Secretary, on the part of the Society of Arts; Viscount Templetown, Sir Hastings Doyle, Dr. D. H. Goodsall, Mr. W. R. Philp, the Rev. William Rogers, Mr. W. E. Stevenson, and Mr. E. C. Keevil, Secretary, on the part of the Society for Preventing Street Accidents. It was resolved to recommend the Council to appoint a deputation to wait upon the Lord Mayor.

PROCEEDINGS OF THE SOCIETY.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday, February 24, 1881; Captain Sir George Nares, R.N., K.C.B., F.R.S., in the chair.

The paper read was—

DEEP-SEA INVESTIGATION, AND THE APPARATUS EMPLOYED IN IT.

By J. Y. Buchanan, F.R.S.E., F.C.S.

Deep-sea investigation, in the sense of exploring the surface of the ocean with the view of discovering new lands, and so determining the boundaries of the sea, has, in all ages, commanded the attention of the more civilised races of mankind, and the most adventurous of their members have ever engaged with enthusiasm in its pursuit. It is probable that the first voyages were undertaken, less with a view to satisfy curiosity, than to render travelling from place to place more expeditious and less irksome. It was not until the mariner's compass had been introduced into Europe, in the 12th century, that long voyages, out of sight of land, could be undertaken; although the enterprise of the Mediterranean mariners enabled them to take their ships as far as Britain without any such aid; and no one who is at all acquainted with practical navigation, will deny the difficulty and the danger of the undertaking. The adoption of the compass as a standard of direction, and the immense amount of valuable property which was consequently risked on the faith of its infallibility, raised a strong interest in the study of the behaviour of the magnetic needle in different localities, especially at sea, resulting in the discovery and investigation of the magnetic variation which, consequently, became a recognised phenomenon to be taken into account in all questions affecting a ship's reckoning. During his voyage, which ended in the discovery of America, Columbus crossed and determined the position of a line of "no variation" somewhat west of the Azores. This line was, by Papal decree, made the boundary between the rival kingdoms of Portugal and Castille, and thus, to the determination of its position, was given a factitious importance which was the indirect cause of much valuable geographical discovery. The first voyages for scientific purposes were thus undertaken for determining the magnetic constants at different places on the ocean, and as these are subject to continual variations, their re-determination from time to time is likely to furnish in the future a motive for frequent maritime expeditions.

It was in connection with the investigation of magnetic phenomena that an exceedingly convenient method of graphically representing the relation between isolated observations, received its first extension. In an ordinary map or chart, one of the principal features is the coast-line. This line represents the most probable direction of the intersection of the sea surface with the land surface, as deduced from observations at isolated points. With greater detail in the survey, the height of points inland above the sea is determined, from which profiles are drawn, and points of equal height on these profiles are connected, and their projections on the sea surface are entered in the map as lines of equal height above the sea, generally called contour lines. When the depth of the land below the sea is determined, the same method of graphic representation is adopted. In a chart, however, all the original determinations of depth are entered, while in the map the general configuration of the country is represented as deduced from the individual observations. Similarly, in rendering the results obtained by the magnetic observer conveniently and intelligibly accessible to the public, and especially to the navigator, the results of the determinations of variation at the different localities are entered in a chart, and points of equal variation are connected by lines drawn at convenient intervals, as from degree to degree, or every five degrees. Here the case of sea and land charts is reversed. At sea the magnetic constants vary gradually, and nowhere abruptly, consequently a chart of magnetic contours of moderately recent date supplies all the wants of navigation. It is otherwise, however, on land, especially in volcanic countries, or those consisting largely of igneous rocks. An almost constant constituent of these rocks is magnetic oxide of iron or loadstone, and the proportion in which it is present in rocks immediately adjacent to one another, often varies within very wide limits. The consequence is, that the needle points in different directions at localities close to each other, so that a survey of such a country would differ very materially, according as the bearings were dependent on solar or magnetic observations.

The employment of contour lines to represent the results first of geodetical, then of magnetic, observations, was extended by Humboldt to the representation of temperature phenomena. They have since been largely used to represent the distribution of other qualities, such as density of sea water, and of plants, animals, &c.

Important, however, as is the investigation of magnetic pheonomena at sea, it is not my intention to refer further to it to-night; it is enough to have pointed out that the interest which it possessed for navigation was the moving cause of the fitting out of the earliest maritime scientific expeditions. Our concern is with the determination of the depth of the ocean, of the distribution of temperature in its waters, of the chemical and physical character of its waters, and of the ground at its bottom, and with the distribution of life in it.

The first problem of deep-sea investigation is to determine the extent of the ocean, its size, its volume. The superficial extent and limits are determined by the surveyor. In order to map out the bottom of the sea, there is only one method, namely, the direct determination of the depth at as many places as possible.

When a ship is "in soundings," the depth is ascertained at frequent intervals by a "leadsman" stationed in some convenient place on the outside of the ship, whence he can throw forward the lead attached to the line which he carries in his hand. The ordinary hand lead line is from 20 to 25 fathoms long, and it is conventionally marked with bits of leather at 2, 3, and 10 fathoms, white bunting at 5 and 15, red bunting at 7 and 17, blue bunting at 13, and with two knots at 20 fathoms. The lead is a long, finely-tapered block, of generally 14 lbs. weight; it has a recess at the thick end, and is perforated at the other end for the reception of the line. This instrument is chiefly used while the ship is in motion. The man entrusted with the duty swings the lead backwards and forwards, and even completely round a vertical circle, in order to generate the requisite momentum to carry the lead well in advance of the ship before it touches the water. It then sinks rapidly, whilst the leadsman's position is advancing to the spot where the lead touched the water. When the line has thus been brought up and down, the depth is ascertained by observation of the marks on the line. It is obvious that by this primitive, but effective, method of sounding, the limiting depth which can be so ascertained depends chiefly on the speed of the vessel, and in a less degree on the skill and strength of the leadsman. Under ordinary circumstances, the method is effective in depths up to twelve or fifteen fathoms, and this degree of efficiency suffices for most purposes.

Occasionally, however, it is advisable to sound in greater depths, without the ship being necessarily stationary. The simplest method of doing so is to reduce as much as possible the ship's way, and having carried the line well forward, to leave it there, and give it line as it sinks. Here the depth and the speed of the vessel should be so proportioned, that the lead reaches the bottom before the ship has passed completely over it. With care, very accurate soundings can be obtained in this way, but the depth must not be much above thirty or forty fathoms.

When the object is to sound in ocean water, where we must be prepared to meet with depths of two or three thousand fathoms, it is essential that the vessel be kept stationary, and if hemp line be used, much heavier weights must be employed. Sounding in great depths is one of the most important operations connected with deep-sea investigations, and it is only within the last thirty years that it has received any very great attention. Probably the first attempt at deep-sea sounding was made by Captain Constantine John Phipps, during his Arctic voyage, in the year 1773, when he was accompanied by Dr. Irving, who made a number of very valuable determinations of the temperature of the sea water at different depths, besides fitting the vessel with one of the earliest stills, which worked well, and supplied the crew with fresh water during the whole cruise. Phipps' deepest sounding appears to have been 683 fathoms. For this purpose, all the lead line in the ship was used, and a lead weighing 150 lbs., which appeared to have sunk about ten feet into the mud, a soft blue clay. With this was sent down a water-bottle, of Dr. Irving's construction, and the water brought up had a pressure of 40° Fahr., that of the surface being 55° Fahr. The density of the water was also measured, and Cavendish's self-registering thermometers were used. So that, at this early date, the methods and objects of deep-sea investigations were perfectly understood. What prevented much work being done was chiefly the want of steam. But little advance was made in this branch of research until after the termination of the French war. In 1818, Captain John Ross made his well-known voyage of discovery to the Arctic seas, in H.M. ss. *Isabella* and *Alexander*. During this voyage, he paid great attention to deep-sea investigation, and invented, and had constructed, one of the earliest satisfactory instruments for bringing up a considerable quantity of the bottom-mud in deep water. He, himself, gives the following account of his instrument and its performances, in the appendix to the account of the voyage:—

"This instrument was invented by me, on board his Majesty's ship *Isabella*, in the early part of our voyage to the Arctic Regions. Many fruitless attempts had been made to procure substances from the bottom of the sea in deep water, by the instruments with which we were supplied, and I had an opportunity of observing the reasons of this failure, which led to the discovery of that which I am about to describe, and which, in almost every instance, completely succeeded in accomplishing that desirable object, of bringing up substances of any description, in considerable quantity, from any depth; but it has also been found to preserve the temperature of any substances, if they are soft, until it can be measured by the thermometer, and by that means the temperature of the earth can be nearly ascertained at any fathomable depth. In Melville Bay, on the 1st of August, it brought up from four hundred and twenty fathoms some soft mud, into which the thermometer was immediately immersed, and it gave 29½°. At the same time, the self-registering thermometer, at the depth of two hundred and ten fathoms, gave the same temperature. In Prince Regent's Bay, in four hundred and fifty-five fathoms, it gave the same temperature. In the entrance of Lancaster Sound, at the depth of six hundred and seventy-four fathoms, the temperature of the mud was also found to be 29½°; and at the highest part of that inlet in which we sounded, the mud was found to be, in six hundred and fifty fathoms, 29°.

"On the 6th of September, in latitude 72° 23′ N., and longitude 73° 07½′ W., we sounded in 1,050 fathoms, from which depth the instrument brought up 6 lbs. of very soft mud. The next day being quite calm, we tried the temperature of the sea at five, six,

seven, eight hundred, and a thousand fathoms, and found its temperature decrease, from 35 gradually to the same temperature as the instrument gave it, which was $28\frac{3}{4}$. Although the instrument may not bring up the mud at the exact temperature of that at the bottom, it may be supposed that it cannot have suffered much alteration, from its agreeing so nearly with the self-registering thermometer, and that, if it has altered, it must be to increase the degree of temperature; hence, it may always be inferred that the mud at the bottom is not of a higher temperature than that brought up by the instrument. The reasons for so little alteration taking place is the closeness with which the instrument confines the mud, which is such as not to allow even the water to escape. If the instrument strikes among stones which are small enough to get between the forceps, it will bring up as many as are enclosed in them; in one instance, it brought up a stone (which weighed two pounds and a half) from 300 fathoms, and, in another, it struck a rock, and cut a piece out, which it brought up from 216 fathoms. The instrument was made from the model by the ship's armourer, and succeeded on the first trial.

"To use the deep-sea clamms, it is necessary to be provided with whale lines, such as are used by the Greenland and South Sea ships, which are two and a half inches in circumference, made of the best hemp, and very pliable and easily coiled; the lines ought to be spliced together, and faked, or coiled, so as to run quite clear on the fore part of the ship's decks. In very deep water it is necessary that it should be calm, or nearly so, to be certain that soundings are obtained in 500 fathoms; but, in a light breeze, the instrument may be hung to a boat, and towed in the direction of the ship's drift, and if there is any wind, it is best to lower all the sails down. An outrigger, fitted with a block, should be fixed in the weather-quarter, through which the line ought to be rove and bent to the instrument, when it ought to be lowered until it is a fathom below the surface, and then let go. The instruments and lines may, however, be made for different depths, and used accordingly. For the North Sea, I would recommend one of fifty pounds."

The cast-iron sinker of the one actually used by Captain Ross was a long, hollow, parallelopiped, weighing one hundredweight.

About the same time as Sir John Ross was prosecuting his voyages on behalf of the Government, Scoresby, in the pursuit of his trade as a whaler, was collecting most valuable information. Of all the navigators who have combined with the due discharge of their duties as sailors the scientific investigation of the conditions of the ocean, the younger Scoresby is certainly the one most imbued with the spirit of the philosopher. The problems to be solved seem to present themselves at once to his mind divested of all irrelevant matter, and he attacks them directly and successfully. In sounding at great depths, for instance, he at once recognises that when the ordinary deep sea line and lead are used, the increasing weight of line, in proportion as more of it is required, renders less certain the determination of the moment when bottom is reached. He determines the density of the water with a thermometer with large bulb and narrow stem, and he gives a table for correcting observed specific gravities for temperature, which shows that he knew that sea water did not attain a maximum of density at the same temperature as distilled water. The following passage from his "Arctic Voyage" will show how thoroughly he knew the nature of the work which he had taken up:—

"The difficulty of getting satisfactory soundings at great depths, arises principally from the uncertain intimation given when the lead strikes the bottom. This uncertainty is increased by using a thick line; for if a lead of a hundred pounds were used, the rope attached to it would require to be so thick that, at the depth of six or eight hundred fathoms, the weight of the line, even in water, would be so many times greater than that of the lead, that scarcely any effect could be observed when it should reach the bottom. Hence, I always prefer a light lead, and a very small line. With a lead of 20 pounds, I have sounded in above 1,000 fathoms, and felt assured that if it had struck the bottom I should have observed it, for the whole of the line in use was not above twice as heavy as the lead; so that the diminution of one-third of the weight would have been very observable. But with a heavy lead and thick line, where the strength of several men is requisite to haul it up, there can be no evidence, without the test of weighing, of any trifling alteration in the strain or weight. Hence, if the lead is found to have been at the bottom, there can be no assurance that a quantity of the line, as well as the lead, has not also been on the ground. To a 20 lb. or 28 lb. lead, I generally attach 200 or 300 fathoms of common log-line, where there is no valuable apparatus along with it, and to this a small lead-line, and finish with a deep-sea line, thus increasing the line in thickness with the increase of weight to be supported; and having the whole of such a weight that the line can be held in the hand, and the least stoppage made perceptible."

After showing how, from observation of the whale fishing, he had often been able to draw correct conclusions as to the depths of water, seeing the amount of line which they would take out when running perpendicularly downwards, he relates the following story, from the log-book of his father, who was also a whaler:—

"At great depths, the effect of the pressure of the sea is not a little curious. My father met with the following singular instance, in the year 1749, which I have taken from his log-book. On the 31st of May, the chief mate of the *Henrietta*, of Whitby, the ship my father then commanded, struck a whale, which 'ran' all the lines out of the boat before assistance arrived, and then dragged the boat under water, the men meanwhile escaping to a piece of ice. When the fish returned to the surface to 'blow' it was struck a second time, and soon afterwards killed. The moment it expired, it began to sink, which, not being a usual circumstance, excited some surprise. My father, who was himself assisting at the capture, observing the circumstance, seized a grapnel, fastened a rope to it, threw it over the tail of the fish, and fortunately hooked it. It continued to sink, but the line being held fast in the boat, at length stopped it, though not until the 'strain' was such that the boat was in danger of sinking. The 'bight' or loop of a rope being then passed round the fish, and allowed to drop below it, inclosed the line belonging to the sunken boat which was found to be the cause of the phenomenon observed. Immediately the harpoon slipped out of the whale, and was, with the line and boat attached to it, on the point of being lost, when it was luckily caught by the encompassing rope. The fish being then released from the weight of the line and boat, rose to the surface; and the strain was transferred to the boat connected with the disengaged harpoon. My father, imagining that the sunken boat was entangled among rocks at the bottom of the sea, and that the action of a current on the line produced the extraordinary stress, proceeded himself to assist in hauling up the boat. The strain upon the line he estimated at no less than three fourths of a ton, the utmost power of twenty-five men being requisite to overcome the weight. The

laborious operation of hauling the line in occupied several hours, the weight continuing nearly the same throughout. The sunken boat, which before the accident would have been buoyant when full of water, when it came to the surface required a boat at each end to keep it from sinking. When it was hoisted into the ship, the paint came off the wood in large sheets, and the planks, which were of wainscot, were as completely soaked in every pore as if they had lâin at the bottom of the sea since the Flood. A wooden apparatus that accompanied the boat in its progress through the deep, consisting chiefly of a piece of thick deal, about fifteen inches square, happened to fall overboard, and though it originally consisted of the lightest fir, sunk in the water like a stone. The boat was rendered useless; even the wood of which it was built, on being offered to the cook as fuel, was tried, and rejected as incombustible."

The incident is exceedingly interesting, as being, perhaps, the first occasion on which the effect of the enormous pressure produced by a column of water was directly observed. It will be observed that the wood, though painted, got completely water-logged, while the whale, which must have penetrated to nearly the same depths, retained its buoyancy.

The plan introduced by the Americans, of using fine twine and a heavy weight, sacrificing both at every sounding, was one which, with a little elaboration, could have been made to give very accurate measurements of depth. And, indeed, when it was found that ordinary observation or feeling did not suffice to indicate when the shot had reached the bottom, the practice of observing the rate at which successive equal lengths of the line passed out, which has since been so useful, was introduced. It is worthy of remark that, at this early date (about 1850), iron wire was used instead of twine, by Lieutenant Walsh, of the U.S. schooner *Taney*.

When telegraphic enterprise began to develop itself, deep-sea sounding became of great practical importance, and, since the date of the first Atlantic cable, it has been carried on both by Governments and commercial companies, with all the energy produced by prospective money-making. For the telegraphic engineer, however, it was not enough to know the depth of the water; it it was of almost equal importance for him to know the nature of the ground on which his cable was to lie. The invention, in 1854, by passed Midshipman Brooke, of the U.S. Navy, of a contrivance to detach the weight used to carry down the sounding-line, while it enabled a specimen of the bottom to be brought up, was of great importance in rendering easier and more accurate the survey of the ocean bed. Brooke's sounding apparatus consisted of a cannon-ball, with a hole drilled through it. Through this hole passed a straight rod, fitted at its upper end with peculiar disengaging hooks. The weight was slung to these hooks by means of a wire, which passed from a ring, which was slipped over the rod under the weight, up on each side of the cannon-ball to the hooks. The sounding-line was attached to eyes in these hooks, and as long as the lower end of this rod was not resting on any thing, the weight was kept securely in its place, and available for taking out the sounding-line. As soon, however, as bottom was reached, and this rod came to be supported on its lower end, the hooks at the upper end fell forward, and allowed the wire to disengage itself. The weight was thus released, and, on the line being pulled up, the rod came away through the perforation of the shot, and brought with it specimens of the mud in small quill tubes fitted in a recess in the lower end of the rod. The principal object which Brooke had in view was to disengage his weight, and his contrivance for doing so is excellent, the moment the end of the rod touches bottom, the weight slips off. In order, however, to gain the greatest possible amount of information from a deep-sea sounding, it is advisable to arrange so that the tube, which is now used in similar machines instead of a rod, should penetrate the ground as far as possible. This is attained by so arranging the apparatus that the weight does not detach at the moment of striking bottom, but only when hauling in is begun. This condition is fulfilled in the instrument used in H.M.S. *Bulldog*, by Sir Leopold M'Clintock, in the year 1860. It is a modification of Sir John Ross's "deep-sea clamm," in which the weight presses the clamm into the ground, until, on pulling in the line, it is thrown off and left at the bottom. This instrument brings up a specimen of what is at the surface of the ground, but does not give a sample of what is below.

The "Fitzgerald" sounding machine was used in the expedition in H.M.S. *Lightning*, in the summer of 1868, when it gave satisfaction. It was tried on board the U.S.S. *Tuscarora*, and Commodore Belknap reports unfavourably of it. From its irregular form, it offers considerable resistance during descent, and in coming up gets the line full of kinks.

At the latter end of 1868, Captain Shortland was ordered to make soundings between Bombay and Aden, and for this purpose he devised and constructed on board his ship, the *Hydra*, a modification of Brooke's apparatus, which gave great satisfaction, and was afterwards used in the *Porcupine* and the *Challenger*. The general arrangement is the same as in Brooke's apparatus; instead, however, of a rod, he has a brass tube, which passes through the centre of the weight, which consists of one or more cylinders of cast-iron. These weights are slung by a wire to a shallow hook, on the upper part of the rod, which surrounds the brass tube. The lower end of the brass tube carries a pair of butterfly valves, and in the middle of the tube are two conical valves opening upwards, between which a sample of the bottom water is secured, while a specimen of the mud is brought up in the lower segment of the tube. In later instruments, the tube was adapted only for the reception of the mud. When this instrument was used, the tube penetrated into the ground until the weights were supported on the bottom, when a steel spring at the upper end of the rod expanded, and threw the bight of the wire off the hook. The weights were thus released, and on hauling in the line, the tube alone was brought up. During the first year of the cruise of the *Challenger*, this instrument was exclusively used, and it gave general satisfaction. The principal objection to it lay in the smallness of the samples of bottom which it brought up. This was due first to the narrowness of the tube, and also to the butterfly valves at the end. The object of these valves is to keep the samples from being washed out, but they also very materially obstruct the

entrances. With a much larger tube, and a rightly ground valve at the top, better samples would have been obtained.

After the first year of the cruise, the "Hydra" machine was replaced by the "Bailey." This was an apparatus very much on the same lines, but differing from the "Hydra," in the size of tube, and the method of disengaging. The tube, which was of iron, was 5 feet long by $2\frac{1}{2}$ inches wide, and weighed alone 25 lbs. The hook which carried the wire and weights formed part of a separate brass piece, which telescoped into the iron tube the moment it touched bottom, thus throwing off the weights without utilising them for pressing the tube further into the mud. The weight, however, of the tube alone was so considerable, that this was of little matter, and the "Bailey" usually brought up large samples of mud. It must, however, be remembered, that though the samples were large in quantity, they were principally from the superficial layer. In working with a tube of $2\frac{1}{2}$ inches internal diameter, a substantial valve of some sort is necessary to prevent the samples falling out when the tube is being brought on board. Such a valve is always a great impediment to the entrance of the mud. It would, therefore, be of great importance to arrange the Bailey tube, so that the weight should be utilised in shoving it into the ground, and also that a greater length of it should protrude beyond the weight. In this way, samples of the mud below the superficial layer would be obtained, and the interest attaching to it is evident. Even with the "Bailey," as it is, we find in several places a red clay at the surface, with white mud below it.

In exploring the seas and lakes of the Highlands of Scotland, I have made extensive use of a form of sounding tube and lead, which I devised for the purpose, and which I have always found to act very well. Its construction is simple, being in effect nothing but a straight brass tube, of one inch diameter, carrying a brass shoulder about one foot from the lower end. A cylindrical leaden sinker of suitable weight is slipped over the upper end, and rests on the shoulder. This line is made fast to a metal eye at the top, and the part of the tube below the shoulder can be unscrewed, and the mud which has been brought up in it squeezed out by a plunger. I have tubes of various lengths, with sinkers of various weights, for work at different depths, and under different conditions. For work in inland lakes it is necessary that every thing should be as light as possible, in order to be suitable for land transport. I use a tube and sinker, weighing in all three pounds; while at sea, with the steam winch available, the sinker weighs generally 28 lbs. Where the bottom is soft mud, these tubes bury themselves in it, and bring up very considerable samples. The samples are also very satisfactory when the bottom is clay; when, however, the bottom is hard sand, or similarly resisting material, the tube impinges suddenly on it, and does not penetrate as deeply as might be wished. The effect is very much as if an attempt were to be made to make a spade penetrate the ground by a sudden blow, instead of a persistent shove. I have designed an arrangement which will enable the tube to exercise a gradual pressure on the bottom, and so to penetrate muds or sands, which offer considerable resistance. Instead of the weight resting on a metal shoulder, rigidly attached to the tube, I suspend it by strong india-rubber cords, from hooks near the top of the tube. When the tube strikes the bottom, the weight delivers its blow gradually through the stretching of the india-rubber. I have had a tube of this kind constructed five feet long, and with a valve at the top. This valve at the top is to prevent the contents of the tube falling out by their own weight, when the apparatus has been taken out of the water, and is being brought on board. These tubes bring up samples of often very coarse sand, and Captain Tizard, who tried one last year in the surveying vessel *Knight Errant*, found that in *globigerina* ooze it was washed out on the way out. I feel sure that, with the india-rubber slings, the tube would penetrate through the layer of comparatively unbroken *foraminifera* on the surface, and plug itself at the bottom with the more finely comminuted and clayey substance which is usually found below. Where the object is to make soundings rapidly, and to get a small sample of the mud on the surface of the bottom (as in sounding for telegraph cables), a lead with a blunt end is used. This penetrates only a small way into the mud, and is easily drawn out, bringing a sufficient sample in the axial tube. Mr. Gray, of the Silvertown Telegraph Works Company, showed me the sinkers used on board their ships. They weigh thirty pounds, and at the bottom of the tube is a very simple and ingenious valve, made of india-rubber, which is pressed against the side of the tube by the lead, while sinking, and expands, and closes the orifice sufficiently to prevent the sample being washed out on coming up.

I now proceed to consider the precautions to be observed in the actual use of these instruments.

On stopping the ship, "to make a station," the first operation is to determine the depth. For this purpose the ship, under steam, is brought head, or in some cases stern, to wind, and kept as nearly as possible stationary while the sounding is being effected. The method of sounding in deep water is essentially the same whether hemp-line or wire is used. In both cases, it is necessary to load the end of the line with such a weight that, in the deepest water which may reasonably be expected, the velocity of descent shall not be diminished to an excessive extent by the friction of the increasing length of line in passing through the water. Twenty years before the *Challenger* sailed, wire had been used on isolated occasions by the Americans, but it was not until Sir William Thomson took it up, and, with characteristic energy, worked it out into a practical method, that it became really available. When the *Challenger* fitted out, it was decided, and, I think, wisely decided, to use hemp-line, which had already yielded valuable results, and the working of which, even at the greatest depths, was familiar to her captain and officers. During the three and a-half years of her expedition, the extension of telegraphic enterprise rendered rapid deep-sea sounding a necessity, and, in consequence, developed both the apparatus and the art. Now-a-days, our sailors are almost as familiar with the handling of wire as with that of rope, and no similar expedition would now start without being furnished with apparatus for using

wire in deep sounding. At the same time, it would be equally improper to start without a sufficient supply of good hemp line, and the apparatus for working it. For we should never allow our affection for what is novel to blind us to the advantages of what is older-fashioned. For many purposes wire must supersede hemp, because it does the work better and more expeditiously, but there are other departments of the work of deep-sea investigation which are better done with hemp. The great advantage of wire above hemp is that, for the same tensile strength, we have a line which passes through the water without developing any serious retarding force due to friction, whereas, with hemp line, the retardation so produced is very great. The saving in time and labour, due to the absence of this frictional retardation, is so great that there can be no question of choice between wire and hemp when it is required to sound in deep ocean water. To take an example, in water of 1,500 fathoms, a three-hundredweight sinker, with the best hemp sounding line, takes twenty minutes to reach the bottom; with wire, and a thirty-pound sinker, the sounding is completed in from twenty-five to thirty minutes.

Although, however, it is thus incomparably superior to hemp for deep sounding, it has disadvantages from which the hemp is free. Its greatest drawback springs from its liability to break. A hemp line may be bent and twisted in any way we please, without its strength being in any way affected; not so, however, with wire. During its whole lifetime it must never suffer a sharp bend, or twist, or nick; if it does, its strength is gone, and if the damaged part is not cut out an accident is sure to happen. Again, Sir William Thomson has always advocated the use of naked steel wire, which rusts easily when moistened with salt water. In order to preserve it, the wire, along with the reel, has to be kept in a tank of water rendered alkaline with soda or lime. This is an inconvenience; but my own experience leads me to the conclusion that there is no reason why galvanised steel wire should not be used, and I find that it keeps perfectly well without any preservative. The objection usually raised to galvanised wire is, that the process of galvanising weakens it. This difficulty I got over by taking No. 20 galvanised instead of No. 22 naked, as recommended by Sir William Thomson. Where steam power is not available for heaving up, the wire possesses a very great advantage, for it can be easily worked, even at very great depths, by hand. The U.S. ship *Tuscarora*, which, in 1874, sounded out the route from San Francisco to Japan, and, in doing so, surveyed the deepest water in the world, did all her sounding by hand. As an instance of what can be done, I will quote from Captain Belknap's report, the work done on the two days, January 17th and 18th. Six soundings were made, all in water over 4,000 fathoms in depth; forty-two observations of the temperature at depths below the surface and 1,200 fathoms were made, and the current was observed at 10, 20, 30, 50, 100, and 200 fathoms below the surface. One of the soundings, the depth being 4,356 fathoms, occupied two hours and twenty-seven minutes, the descent occuying fifty-three, and the reeling in ninety minutes.

With steam power at hand—and without it, it would be folly to attempt deep-sea work—hemp line becomes preferable to wire, where the other branches of deep-sea work are being carried out, such as serial temperature observations, and the collection of water samples from different depths.

Deep-sea thermometers which have been carefully compared with a standard, and which have been used in many soundings, are instruments of very great value, and if lost cannot be replaced by the purchase of new ones. Hence, in making such observations, the conditions which we have chiefly to keep in view is the safety of our thermometers, while, for the completeness of our work, it is important that the temperature should be observed at as many different depths as possible. Now, as the chance of the hemp-breaking is very small when compared with the wire, it is permissible to risk a greater number of thermometers on it than on a thin wire. Therefore, to get the same number of observations with the wire would require the operations of sinking and heaving in to be repeated a greater number of times than with the hemp, and as a thermometer must be allowed a certain time to take the temperature of the water, it will be seen that for such work the wire is in the end no more expeditious than the hemp, and the use of it is attended with considerable risk of the loss of valuable instruments. I am quite convinced, from my own experience, that for all work in depths up to 500 or 600 fathoms, hemp is better for all purposes, because a sinker can be used, which will make it descend nearly as quick as wire, and, with a steam winch, it can be brought up at nearly the same rate.

The wire has, of course, the advantage, that it stows in a much smaller space than ordinary sounding line.

Finally, and to answer the question which is often put to me, whether wire or hemp should be used in a ship's outfit, I would say take both, as they are both useful in their proper places. For determining the depth, use wire; for detail work, with the thermometers and water bottles, use hemp. In this way your sounding will be done expeditiously, and you will not lose your instruments.

With regard to dredging, which forms a very important department of deep-sea investigation, there can be no doubt of the great superiority of wire over hemp rope. The advantage in point of rapidity of work, and of stowage space, is much greater than in the case of sounding. Here, again, we are indebted for a scientific instrument to the enterprise of telegraphic engineers, for if it had not been a necessity for them, it is not likely that we should now have had the very beautiful flexible steel wire hawsers which are to be found in nearly every ship.

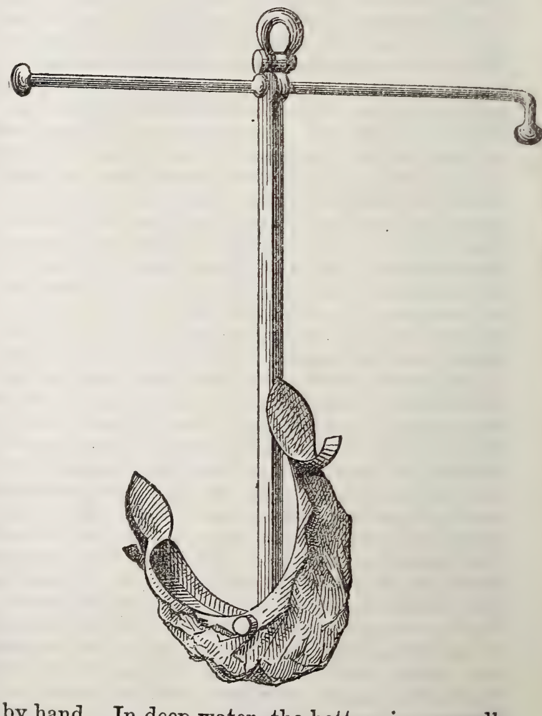
Steel wire rope was first used for deep-sea dredging by Professor Agassiz, in the winter 1877-78, and he has continued to use it with great success. His rope "was one and one-eighth inches in circumference, and was composed of six strands laid round a tarred hemp heart. Each of the six strands was composed of seven galvanised steel wires of No. 19 American (No. 20 Birmingham) gauge. The ultimate strength of the rope was 8,750 lbs.; weight per fathom 1·14 lb. in air, and approximately 1 lb. in sea water; price, eight cents. per foot."

In the summer of 1878, I fitted the steam yacht *Mallard* with a steel wire dredging-rope for work in depths up to 200 fathoms. It consisted of five strands, arranged around a centre of cotton, and each strand consisted of seven steel wires (No. 24 B.W.G.) 0·023 in. in diameter. The diameter of this rope is 0·19 in., and circumference, 0·6 in.; its weight per fathom is 0·33 lb., and breaking strain 20 cwt. It was, unfortunately, not made of galvanised wire, and has now been in use for three seasons without being kept in any kind of preservative; and although necessarily rusty, its worst fault is that, when in use, it is apt to stain the deck.

In deep water, Captain Sigsbee gives the following as safe work:—Time per hundred fathoms, paying out and hauling back, three to five minutes, according to circumstances. He reports a good haul having been made in 800 fathoms in one hour and twenty minutes, including twenty-three minutes for dragging.

My object in furnishing myself with the wire rope was not to dredge, but to be able to anchor in the deepest water to be found on the west coast of Scotland, and thus facilitate the carrying out of physical and chemical observation on the water. In 1877, when I explored a large number of the Scottish lakes and sea lochs, I had found that, in a fresh-water lake, the vertical distribution of temperature is often very different in one place from what it is in another place not many hundred yards distant. The same was also found, though in less degree, in sea-water lakes. It became, therefore, of the utmost importance, in investigating the conditions of temperature in the water, to be sure that the observations were really all made in one and the same place. It is impossible to keep a vessel stationary in one position by means of steam, unless, perhaps, in a land-locked bay, with a breeze blowing sufficiently strong to make the vessel drift faster than her lowest rate of steaming. It became, therefore, of the greatest importance to be able to anchor anywhere, and for this purpose the rope above described was furnished. In the season of 1878, I used a kedge anchor of ordinary form, and weighing 84 lbs. It was attached to the wire rope by means of about twelve fathoms of 2½ inch Manilla rope. Often a couple of furnace bars were strapped on to the Manilla at five and ten fathoms from the anchor, with a view to keep a curve on the line. This arrangement was found to work extremely well. Everything was prepared before hand, and when the vessel was in position the anchor was let go, and the wire rope allowed to run rapidly off the reel, the strain on the break at the reel being carefully regulated by means of a spring balance, so that the moment the anchor touched the bottom, the reel stopped. The break was then secured at a known strain, such that as the vessel drifted she would take what rope was required. There was thus no paying down of slack line on the top of the anchor. When it was judged that enough rope had been given, the strain on the break was increased, which by gradually bringing the weight of the ship on the anchor, steadied it into the ground. When the anchor was found to be holding, the reel was secured in such a way that, if necessary, it could easily be cast loose, and the vessel being stationary, and at anchor, the work could proceed. It is of great importance that the wire rope should be held fast on board in such a way that it can be easily let go; for, if the anchor begins to drag, then the ship gathers way, and if now the anchor suddenly holds, and it is impossible to veer cable, a very excessive strain is put on the rope in order to stop the ship's way in a very short distance. If, however, the reel can be released, then, by careful working of the break, the anchor can again be steadied into the ground, and the ship stopped without any undue strain being applied to the rope. The rope passes out over the bow of the vessel through a metal block on one of the iron davits used for "catting" the anchor. From this block it is led through another block, which is attached to a spring balance, to the drum of the steam-winch. The angle made by the line between the winch and the outer block is always the same; consequently, the strain shown by the spring balance is always the same fraction of the total strain on the line. This fraction, in our particular case, is as nearly as possible one-third. In heaving up the anchor, it is only necessary to watch the spring balance in order not to over-strain the line. The moment which requires very careful attention is when the anchor is being started out of stiff ground. By careful handling of the winch, the strain is kept steady until the anchor comes away, which is shown by the index of the balance jumping suddenly back when the cable is rapidly wound in. It is taken from the winch by the reel, which is wound up

Fig 1.



by hand. In deep water, the bottom is generally covered by a surface layer of very soft mud, having no holding power; it is necessary, therefore, to allow the anchor to sink by its own weight through this before any great strain is brought on it.

During the summer of 1878, the anchor used as described brought up so many valuable specimens of this kind, especially of those existing below the surface layer, that I determined before the next season to provide myself with an anchor which should not only hold the ship, but retain the mud into which it had fixed itself. It is essentially a Trotman's anchor, with an open frame, instead of a solid bar connecting the two palms. To this frame is laced a stout canvas bag, into which any mud sticking to the palm, at the moment of breaking out of ground, falls (Fig. 1). This has proved itself a most successful instrument for exploring the bottom of the seas, especially where the object is to collect the mud itself, rather than the things that live on its surface. Also, as an anchor pure and simple it is most efficient, being constantly used as an ordinary kedge-anchor.

The economy in stowage, caused by using wire rope, such as I have described, will be very apparent if we consider the amount of it which can be wound on a reel of moderate size. Let the diameter of the core of the reel be 18 inches, and the diameter of the rope 0·2 inch, then if carefully and tightly wound on such, a reel will hold sixty turns per foot of length. If the cheeks of the reel be constructed so that rope may be wound on it until the outside diameter of the coil is 28 inches, then the average diameter of one turn of wire rope is 23 inches, and the average circumference one fathom, and the number of turns counted in the direction of a radius would be fifty. We should then have, on a reel 1 foot long by 2 feet 4 inches in diameter, 3,000 fathoms of wire-dredging rope. If the diameter of the cheeks were made, say, 2 feet 8 inches, then 3,000 fathoms would be easily accommodated, even without great care in winding. The whole weight of the line would be 1,000 lbs. It would, however, be advisable, if dredging were to be attempted at such depths, to graduate the size of the line; for it is quite evident that, with 3,000 fathoms of it out, the part at the surface of the water has to sustain all the strain due to the dragging and the weight of the line, or 9 cwt. weight. As the breaking strain when new is 30 cwt. weight, there would be an insufficient margin. Doubts have often been thrown on the trustworthiness of deep soundings, as carried out in the ordinary and simplest way, using a hemp-line and heavy sinker, and keeping the ship as stationary as possible. The sources of error most frequently are, or at least were, the compressibility of water and the existence of currents, principally under-currents.

When a liquid suffers compression, its density is increased; consequently, it was asserted, that at some very great pressure, the density of water will become equal to that of lead, and our sinkers, instead of sinking, will float. Were water compressible in the degree that air is compressible, then the density of water might increase at such a rate as to make lead float, supposing the lead to remain meantime uncompressed; but, whereas the density of air is doubled by raising the pressure worked on it from that of one atmosphere, or 30 inches of mercury, to that of two atmospheres, or 60 inches of mercury, the density of water is only increased by one twenty thousandth. Now, supposing that the compressibility remains the same at high pressures as at low, it would require a pressure of twenty thousand atmospheres to raise the density of water from one to two, and more than two hundred thousand atmospheres to raise it to the density of lead. One hundred fathoms of sea water exert a pressure of about eighteen atmospheres; and we may assert, with perfect confidence, that the deepest water in the globe is under five thousand fathoms in depth; therefore, even at the greatest possible depths, the density of the water could not be raised by as much as one-twentieth by pressure alone, and the sinking power of lead, which is itself rendered denser by pressure, could not be appreciably affected. This objection to the validity of deep soundings would not have been worth referring to, were it not that it has been admitted by persons of high authority, and has, by consequence, influenced a large number of persons whose convictions are determined by authority alone. Admiral FitzRoy, for instance, in an appendix to his volume on the voyage of the *Beagle*, says, "The depth to which bodies would sink in an ocean several miles deep has not been proved, and there is reason to think that it is much less than people generally imagine," &c. Scoresby, however, twenty years earlier, with his usual acumen, was able to attach its proper value to objections on this ground. He says:—"In sounding at great depths, where the pressure of the water becomes equal to, perhaps, several hundreds weight on every square inch of surface, some persons have imagined that even lead cannot sink, but will be suspended midway in the sea. I have conversed, indeed, with very intelligent persons, who could not be persuaded that any dependence could be placed on soundings obtained at a depth exceeding 300 fathoms. Were water a compressible substance, like air, it would be possible that, under a certain pressure, it might become as heavy as lead, so that lead, or any other ponderous body, could only sink to a certain depth; but water being incompressible, or nearly so, it is clear, however great the pressure may be, that it must be the same downward as upward, on any body suspended; consequently, bodies specifically heavier, will continue to gravitate downward, whatever be the depth or the weight of the column of water above them."

The other objection to the trustworthiness of deep soundings is a real one, though it is often exaggerated. There is no doubt whatever about the existence of surface currents of great extent and velocity in the midst of the ocean; they are observed and measured every day as they form a very important factor in the navigator's daily reckoning. Before deep-sea investigation had received the development which it has now, it was quite uncertain whether these currents (the Gulf-stream, or the equatorial current, for instance) were confined to the superficial layer of water, or extended in all their force to the bottom. No sooner, however, had soundings been attempted in them, than it was found that they were comparatively superficial; but, notwithstanding that they were on the surface, and, therefore, immediately under observation, they caused so much deviation in the direction of the sounding-line, and such uncertainty in the stationariness of the ship, that soundings so obtained were always considered uncertain. It was then said, if we have these

surface currents running from one part of the ocean to another, we must have return currents of some kind, and it is likely that these will be for the most part under-currents; if, now, a surface current, which you have immediately under your eye, gives you so much trouble, how much more will this be the case with an under-current of whose strength, and direction, and depth, you are ignorant?

It must be admitted that when we do meet with currents of the kind imagined, soundings taken in these, whether with wire or hemp line, are very much less to be relied on than those taken in manifestly quiet waters; but, on the other hand, the existence and extent of under-currents has been very much exaggerated. By far the larger portion of the ocean is, for sounding purposes, practically still water. The surface currents of any importance are easily recognised, and so also are the under-currents. Just as a physician can, by bringing his experience to bear on the sounds transmitted to him through the stethoscope, divine what is taking place inside the body of his patient, so the experienced seaman can, by observing the behaviour of his sounding-line, form a fair diagnosis of what is taking place in the depths of the sea. When the sinker passes into a belt of under current, the fact is very soon apparent, and calls for the greatest care in the manœuvring of the ship. Even with the greatest possible care, however, soundings, taken under such circumstances, would always be considered to be of doubtful value. If no bottom is brought up, they should be looked on as very doubtful, and even discarded; if bottom is brought up, then we know that the depth is not greater than the line used, and a correction, suggested by observation and experience, may be applied, which will bring the depth very near the truth. Although, as we have said, by far the greater part of the ocean may be looked on as still water, and, therefore, favourable for investigation with the sounding-line, it is, nevertheless, of great importance to obtain accurate measurements of the depth of water under well marked currents.

It is evident that this cannot be satisfactorily done by the sounding-line alone, and it early occurred to those who thought on the subject that the method which promised most success was that which should give the depth in terms of the height of the column of water; in other words, the barometrical measurement of altitudes was extended from the land to the sea. Many and various instruments have been suggested and used for the purpose. They are all constructed with a view to record the amount of compression produced on a given mass of a certain elastic substance. From the known law regulating the variation in volume of the substance with variation in the pressure, the maximum pressure to which the instrument has been exposed can be deduced, and from the known density of the water, the height of the column of it, which would produce this pressure, can be calculated, and this height is the depth to which the instrument has been sunk. Many different substances have been used for this purpose, and foremost amongst them air, on account of its great compressibility. For deep work, however, this was quickly found to be a great disadvantage, so great, in fact, that it has never been satisfactorily used at considerable depths.

The compressibility of water was discovered in 1762 by John Canton, and, fifty years later, in extending Canton's original observation to higher pressures, Perkins sank his instruments to various depths in the North Atlantic Ocean, on a voyage from America to this country. These instruments were glass tubes, sealed at one end, filled with water, and inverted in a cup of mercury. In the tube was a steel index which rose with the mercury, and was retained by a spring at the highest point reached. It could be drawn down again, and the instrument so reset by means of a magnet applied to the outside of the tube. Encouraged by the results so obtained, Perkins constructed a hydraulic apparatus, in which he could expose his instruments to enormous pressures, which he measured directly by the weight which a plunger could support. He, at the same time, suggested the use of these instruments, or piezometers, for determining great depths. The same suggestion was repeated in 1848, by Aimé, to whom we owe many valuable researches in the Mediterranean, and by the United States Coast Survey a few years after. The same idea occurred to myself in view of my appointment to the *Challenger*, and, indeed, it is one of those ideas which necessarily suggest themselves to any one who seriously reflects on the subject. The form of piezometer which seemed to me to be best suited for the purpose, was essentially that of Perkins, with certain convenient practical modifications. For filling the

Fig. 2.

instruments, I used generally distilled water, and sometimes sea water, or an equivalent salt solution. The bulb and stem of the instrument were so proportioned that, for a depth of one hundred fathoms, the apparent contraction of the water occupied a length of ten millimetres. Some, however, were more, and others less, delicate than these. My object in using water, or weak salt solution, as the elastic material, was that, as the temperature of maximum density of these liquids was not far removed from

that obtaining in the great mass of deep oceanic water, a considerable inaccuracy in the determination of the temperature of the water would make no sensible difference in the apparent volume of the liquid, and therefore would not senibly vitiate the depth determination so obtained. Unfortunately, the vicinity of the temperature of maximum density exercises an influence on the compressibility, which counterbalances its advantages from a thermal point of view. A strong salt solution would probably be better. Were the temperature at the bottom of the ocean subject to great variations, the use of distilled water would be quite inadmissible, but over large areas, its variations are confined to fractions of a degree. Hence, the irregularities in the depths given by the piezometer, and due to this cause, are small though not absolutely to be neglected. I am engaged, at present, in experiments to determine what is the best liquid to use for this purpose.

Another method of measuring the pressure, and through it the depth of the sea, is by means of an instrument much resembling, in principle, the aneroid barometer. Its simplest form is that usually given to a mercurial thermometer. When the pressure on the outside of the instrument is increased, the bulb experiences a tendency to collapse. It yields wherever its walls are weakest, and if the pressure is kept within the necessary bounds, a flattening is produced, which reduces the internal volume of the bulb, and forces the mercury into the stem; if an index is fitted in the steam, its position will indicate that of the extremity of the mercury at the moment of greatest compression. Inventions on this principle have been patented over and over again in the course of the last twenty or thirty years.

The chief objection to the instrument is that, in practice, it is always filled with mercury. Over the greater part of the ocean, the temperature of the water falls as the depth increases. Hence, the mercury will be continually retreating, owing to its contraction due to fall of temperature, while it is being pushed forward by the mechanical collapse of the bulb. Until these two effects compensate each other, there can be no movement of the index, and, therefore, no indication of the depth. In water of tolerably uniform temperature, as in Polar regions, it ought to do well. Two instruments of this kind were sent to the *Challenger* by Mr. Casella, but they only reached her at the last port before her return to England. They were only used twice, and did not on those occasions give satisfactory results. Sir William Thomson has, within the last year, patented an instrument on the same principle, where the collapsible envelope is a very flat brass tube.

Very analagous to sounding in a current is the operation of sounding from a vessel in motion. We have already described the ordinary operation of heaving the hand-lead, by means of which depths up to twelve or fifteen fathoms can be correctly observed under ordinary circumstances. In deeper water, however, and with vessels running at the high speed now common amongst mail steamers, a self-adjusting apparatus is an essential. Up to within the last few years, the commonest form of apparatus of the kind was Massey's sounding machine. In sinking, the friction of the passing water caused a screw fan to rotate, and the number of its rotations was recorded on dials in much the same way as the distance run by a ship is recorded by Massey's patent log. The form of this instrument, requiring, as it does, a system of multiplying wheels, causes it to offer considerable resistance when being hauled on board again; it is, therefore, not suitable, except for vessels going at a moderate speed. Further, if we look to the principle of the instrument, we see that what it in fact registers is the distance travelled by the instrument between the surface and the bottom. If it has been allowed to sink freely, then this distance will be equal to the depth of the water. But if, while sinking, it were exposed to a certain amount of drag, through strain on the sounding-line, it would tend to sink sideways, which would put the screw fan to a disadvantage, and vitiate the determination of depth. Practically, this objection has little force, because, in a ship where it is thought proper to execute soundings of the kind, there will be no difficulty in seeing that the sounding-line runs out freely.

In arranging for taking soundings from quickly moving ships, it is important to have not only an instrument which will be dependent only on the true depth of the water for its indications, but also such mechanical appliances as will enable the operation to be carried out safely and expeditiously. To Sir William Thomson is due the credit of having furnished the practical solution of this as of many other problems. His original apparatus for registering the depths was a glass tube, sealed at one end, and coated internally with a chemical preparation (chromate of silver) the colour of which was changed by the action of sea water. As the tube, with its included air, sank, the volume of the air diminished, and the sea water penetrated further and further into the tube, until the bottom was reached. On rising to the surface again, the elasticity of the air reasserted itself, and eliminated the water which had entered. The height to which the water had risen was given by the extent to which the internal coating of the tube was altered. The indications of this instrument were always very good, and the practical objection to it lies in the fact that a tube only serves for one sounding, and that, therefore, a number of these have to be carried.

In June, 1879, I patented an instrument, in which the degree of compression to which an enclosed mass of air had been subjected, was measured by the water which had gained admittance to the instrument.

As I now use it, the instrument is represented in Fig. 3. It consists of a glass tube open at both ends, but capable of being closed by a stopper or other means. At some part of the tube a spout is introduced, and the tube is bent over through two right-angles immediately above it. When the instrument is to be used, the end is closed, and the line let go; when bottom has been reached, it is brought up again, and we find that a certain amount of water has lodged in the lower part of the tube. It is evident that, as the instrument descends and the air in it is compressed, the water forces its way in through an orifice, and past the spout. This spout is so formed that it delivers the water against the walls of the tube, down which it runs, and collects at the bottom. When the motion of ascent begins, the air, by its elasticity, tends to re-

cover its original volume, and expands in the direction of greatest freedom. Now, all the water which has entered has collected below the spout, consequently, in re-expanding, this water will be left undisturbed.

Assuming that the volume of the mass of air in the instrument varies inversely with the pressure to which it is subjected, we require, in order to be

FIG. 3.

FIG. 4.

able to construct a scale for our instrument, and so to interpret its results, to know the total volume of the tube, the volume of the part which I call the vestibule, the dimensions and volume of the narrow tube, and of the wide one. Then, if V be the total volume of the tube, and v that of the vestibule, the amount of water which gains admittance when the pressure is raised from one to p atmospheres is—

$$v^1 = V - \frac{V}{p} - v$$

$$= V\frac{p-1}{p} - v$$

The methods by which a correct scale of fathoms can be easily applied to any instrument, and engraved either on the glass or on the metal case, or on both, are details of practical instrument making, which need not detain us.

Convenient dimensions for such a sounding instrument are—Total volume, twenty cubic centimetres; volume of vestibule, one cubic centimetre; length, forty to fifty centimetres. In hauling in the sounding line to a vessel under way, the machine comes to the surface a considerable distance astern of the ship, and then has to be towed through the wake, necessarily often dipping under the seas. Each dip which it makes constitutes an independent, though shallow, sounding, and the volume of the vestibule must be so proportioned to the volume of the instrument, that during such immersions no water shall pass the spout. When the instrument has been read, it is at once available for a fresh sounding; it is only necessary to remove the stopper, and let the water run out, and then replace the stopper again. Fig. 4 represents an instrument modified so that it can be used either for great or for small depths, according as either end is closed.*

Sir William Thomson, in his latest specification of patent (February, 1880), recommends a group of three instruments, constructed somewhat on the lines of the above instrument, but composite and of sizes so apportioned that each shall be peculiarly sensitive at certain depths. He also recommends the use of the "elastic bottle gauge," alluded to above, combined with the triple air compression gauge, to give measurements of from 11 fathoms to 300 or 400 fathoms.

It may reasonably be doubted if it could ever be a matter of any importance to the practical mariner to obtain a positive sounding in 300 or 400 fathoms of water, either with or without stopping his ship, and to do so without checking her way would be a very serious undertaking. The weight and wire will not sink at a greater rate than about 100 fathoms per minute, or four minutes for four hundred fathoms, and during four minutes a ship going not more than 10 knots per hour will have advanced by 660 fathoms, so that, when bottom has been struck, there will be at least a thousand fathoms of wire, which, even with steam, could not be reeled in under a quarter of an hour.

The second and more mechanical part of the

* After the above was written, my attention was drawn by the Hydrographer, Captain Evans, to an instrument identical in principle, though differing greatly in the details of construction, invented by Ericssen, and used successfully on board several of her Majesty's ships. It is described and figured in the *Nautical Magazine* for 1836, and is reported on very favourably by Captain Bisson, of H.M.S. *Partridge*, who was accompanied by the inventor, and they obtained successful soundings, in depths up to 80 fathoms, while going at a rate of six knots per hour. Along with the sounding machine, Ericssen brought on board a reel of wire for use, in place of sounding line. Captain Evans informed me that it had been constantly and successfuly used under his own eyes, when engaged in the survey of the New Zealand coast, in H.M.S. *Acheron*, in 1848, and that it had given great satisfaction.

problem of deep sounding while under way, has been solved by Sir William in an elegant and practical form. His navigational wire sounding reel contains all that is requisite in the smallest possible compass. For my own work, I have made some slight modifications in the details. My reel consists of a solid hard wood core, thoroughly well painted, and surrounded with a brass rim, in the hollow of which the wire is wound, and outside of which, on each side, is a break pulley. Pieces of soft hemp line are used for the breaks. The one which is used purely as a friction break is attached at one end to a spring balance, by means of which any definite pressure can be put on the reel. The other is used as a locking break, that is to say, it is taken one complete turn round this pulley in the direction in which it revolves when the wire is running out. When the weight has been observed to strike the bottom, this break is suddenly tightened, which instantly locks the reel when the handles are manned, the breaks thrown off, and the wire wound in. I depart, also, from Sir William Thomson's practice in using galvanised in place of bright steel wire. In order to allow for any possible weakening effect of the galvanising, I take the wire a size larger. In a small vessel like the *Mallard*, I found it very inconvenient working the reel on the taffrail. I have it now well in board, and the wire leads out through a metal block, specially constructed for the purpose, and attached to the flag pole, as high up as a man can reach. In this way the work is carried out without difficulty. The galvanising is a perfect protection to the wire, and all work with tanks and alkaline solutions is spared. Instead of having a heavy iron link at the end of the wire, I reeve the end of the wire through a piece of ¼-inch block-tin gas pipe, about 15 inches long, and then bend it round and splice up the end of the wire so as to form an eye, to which the stray line for sinker and sounding machine can be attached.

In the U.S. Coast Survey Report for 1857, a very ingenious sounding instrument is described by a Mr. Hunt. The instrument consists of an air-tight bag, made of flexible material, with a long flexible tube attached to it. This bag, being filled with air, is sunk to the bottom (in a moderate depth of water), preferably by a heavy grating which surrounds and protects it. The other end of the flexible tube is connected with a Bourdon's pressure-gauge in the ship or boat. If, now, this bag be towed over the bottom, and the pressure-gauge observed on board, an exact profile of the bottom is given. I am not aware that this instrument has ever been much used for harbour surveying—for which it was intended—and it is not difficult to see where practical difficulties would be likely to occur; it has, however, been used with some success as a tide-gauge, and it is clear that, for such a purpose, it possesses many advantages. The bag being securely anchored under water, it can be connected by a pipe of any length with the indicating gauge, or a recording instrument under cover.

For the purpose of observing the temperature of the waters below the surface in lakes and seas, two classes of thermometers have been used, namely, ordinary thermometers and self-registering ones.* The earliest observations were made with the ordinary thermometer, and it was used in one or two ways; either it was sunk itself to the desired depth, and was so enveloped and protected by badly conducting material, that in bringing it up again through the layers of water of different temperature it had not time to alter its own temperature, or a quantity of the water at the desired depth was enclosed in a bucket of suitable construction, and brought to the surface, and then immediately tested with the thermometer. Many very excellent and trustworthy observations exist, which have been made in one of these ways. Our first knowledge of the temperature of the deep water of fresh-water lakes was obtained from the observations of De Saussure, on the lakes of Switzerland, made with a thermometer, so padded and protected that it could be drawn up through 1,000 feet of water, of any temperature likely to be found in Nature, without sensibly altering its temperature.

The self-acting bucket, or sea-gauge, was used at an earlier date in the determination of the temperature of the deep water of the ocean. The accuracy of the results obtained by this method depends greatly on the skill of the observer. In the case of De Saussure, and of Fischer and Brunner, the results are clearly to be relied on implicitly. In the experiments with the sea-bucket, also, excellent results have been obtained. The results obtained by both methods of experimenting will be the more accurate the more uniform the temperature of the water. The temperature, especially of the bottom water, has also frequently been determined by bringing up a quantity of the mud, and taking its temperature when it arrives on board. This method also gives very satisfactory results when a considerable quantity of mud is at disposal.

Self-Registering Thermometers. — By far the greatest number of observations has been made with self-registering thermometers of one form or another. The first self-registering thermometer was made by Cavendish. He constructed both a maximum and minimum thermometer, and they were of the kind called by the French *à diversement* out-flow thermometers. In fact, his maximum thermometer is in every particular identical with that known in France as Walferdin's; his minimum is on the same principle, but has a U-formed stem instead of a straight one. The disadvantages of this form of thermometer are two—namely, the indications are not continuous, but by jerks, depending on the size of the mercury drops, and they require to be constantly set, the maximum at a higher, and the minimum at a lower temperature than the one to be observed; they also require constant comparison with a standard. They are, therefore, not suitable for use where many observations have to be made expeditiously.

In the year 1782, Six published a description of the combined maximum and minimum thermometer which bears his name, and which has since continued to assert its place among meteorological instruments as perhaps the best self-registering thermometer. The instrument is too well-known to require particular description. It may, however, be noted that Six himself did not use a hair for a spring to keep his indices from falling down, but a fine glass thread soldered to the top of the index, and sticking up in a direction very slightly inclined to that of the length of the index, so that it pressed

* Proceedings of the Royal Society of Edinburgh, 1880.

gently against the sides of the tube. The advantage of the glass over the hair is that it does not lose its elasticity; but, on the other hand, the index takes up more room, and requires a thermometer with a larger stem.

Maximum and minimum thermometers, such as Cavendish's and Six's, when used for deep-sea exploration, show only the maximum and minimum temperatures to which they have been exposed in any one excursion, and a single observation with such a thermometer does not give us with certainty the temperature of the water at the depth to which it has been sunk. Hence, if we had a right to assume that the temperature of a sea or lake might vary in any conceivable way with the depth, these instruments would be valueless. We have, however, no right to make this assumption; we know, on the contrary, that in all seas whose surface is not exposed to a freezing temperature, the temperature of the water will, as a rule, diminish as the depth increases, that, therefore, the minimum temperature, as shown by the self-registering thermometer, will, in fact be the temperature at the greatest depth attained by this thermometer. Hence, in such cases, this instrument is to be relied on, and more especially when series of temperatures are taken—that is, when the temperatures at different depths in the same locality are taken, so that the evidence of the decrease of temperature with the increase of depth, is rendered as strong as possible. In order to render an account of the state of any lake or sea, as regards temperature, it is absolutely necessary to have such serial observations; hence, for such investigations, the maximum and minimum thermometer is not only trustworthy, but a most valuable and, indeed, indispensable instrument, for it has the great advantage that, as it is in the strictest sense self-registering, any number can be attached to the same line, and so, at one haul, the temperature can be observed at a number of different depths.

For isolated observations, the thermometers just described are not so satisfactory, and a very great amount of ingenuity has been displayed in the invention of machines for registering the actual temperature of the water at any depth, independently of that of the water above it.

None of the instruments devised for this purpose have been strictly self-registering; they have all required some assistance from the observer, who, by various forms of mechanical appliance, brings about a catastrophe which leaves its mark on the condition of the instrument. It is obvious that any control which an observer may have over an instrument separated from him by, it may be, three or four miles of cord, is very limited, and is, in fact, confined to his ability to move it towards or from him. By a simple mechanical contrivance, this longitudinal motion may be made to produce one of rotation, and, in fact, the assistance afforded by the observer to the thermometer, to enable it to register its own temperature, consists in his turning it either upside down or through a whole circle when it has reached the desired depth. The first observer who made use of this device was Aimé. His working arrangement is described in "Ann. Chim. Phys.," 1843 [3], vii., p. 497. It is worked by a weight, which is allowed to slip down the line, and which then sets free the apparatus.

His *thermomètre à bascule*, along with a number of ingenious modifications of existing forms, is described in the same journal, 1845 [3], xv., p. 5. It was unfortunately only after he was obliged to leave the Mediteranean, which had been the scene of his labours, that he invented the very elegant combination of thermometers by which he was enabled to ascertain the temperature at any depth, no matter what the intervening distribution might be. It is described in the memoir just cited. It consists of two outflow thermometers, so constructed that the one of them registers the sum of the rises of temperature, and the other the sum of the falls of temperature, to which it is exposed in any excursion. When they have reached the required depth, they are inverted, and on their way back to the surface they register, as above described, the rises and falls of temperature to which they are exposed. If r be the sum of the rises of temperature, and f the sum of the falls, s the temperature at the depth where they were inverted will be $a = s + r - f$.

If they are allowed to register on the way down, and then inverted at the greatest depth, so as not to register on the way up, the effect will be precisely the same, though the functions of the thermometers will be reversed.

Beautiful and ingenious as Aimé's thermometers are, they have the disadvantages common to all outflow thermometers; they are neither simple enough nor handy enough for work involving many observations. The inverting thermometer, patented by Messrs. Negretti and Zambra, satisfies the conditions required of a thermometer for isolated observations as completely as can be hoped for. It is a mercurial thermometer; the bore of the stem is contracted to the smallest possible diameter at a point about an inch from the neck of the bulb. As long as the thermometer is standing vertically, stem uppermost, the mercury is continuous in stem and bulb; but if it be inverted, the mercury parts at the contraction, the portion in the stem falling down into the point. The stem is graduated from the point towards the bulb, and the temperature, at the moment of inversion, is read off by the height of the mercury in the end of the stem. This thermometer exists in two varieties, the one with a U-formed stem, which requires to be turned completely round. The turning arrangement for the latter instrument is a somewhat elaborate and expensive instrument, but it answers its purpose. The inverting arrangement, supplied with the half-turn thermometer, is somewhat clumsy and unsatisfactory. The half-turn instrument, when fitted with a suitable investing arrangement, is to be preferred to the others in all work at moderate depths.

Sources of Error in the Indications of various Thermometers.—When an ordinary thermometer, protected by badly-conducting envelopes, is used, it is obviously exposed to alteration of temperature by being pulled through warmer or colder water on its way to the surface. Whether any sensible error is likely to result from this cause, must be determined in each particular case by experience. The more perfectly it resists change of temperature, the longer it will take to assume the temperature of the water. De Saussure left his thermometer down for twelve or fourteen hours for each observation, so that this method is now seldom used.

Similarly, also, the method which depends on bringing up a sample of water in a vessel fitted for the purpose, and taking its temperature with an ordinary thermometer, when it reaches the surface, has been discontinued; for although it does not take more time than would be necessary for sending down a thermometer and bringing it up, it is impossible to bring up water from great depths in warm climates without sensible change of temperature.

In the case of outflow thermometers, the delicacy of the instrument is limited by the size of the mercury drops. In the inverting thermometers of Negretti and Zambra an error may arise from the difference of volume of the mercury in the stem, at the temperature at which it was inverted and at that at which it is read. In an extreme case this may amount to as much as O. 4° F.; it can, however, be allowed for.

In Six's instrument there is a possible error from looseness of the indices, in consequence of which they are apt to be shaken out of their places by any jarring of the line. Errors from this source can be avoided to a great extent by attaching the thermometer to the line, by means of an elastic or india-rubber tube.

All the self-registering instruments are liable to error from the effects of pressure. The pressure inside a thermometer is never greater than that of the atmosphere when it is sealed up. It may, however, be exposed outside to a pressure of 500 to 600 atmospheres. The effect of this difference of pressure on the outside and inside of the glass envelope is to make it tend to collapse. The bulb of the thermometer is squeezed, and its volume, in consequence, diminished. The liquid which it contains is thereby forced into the stem, and its apparent volume is greater than it would have been, had there been no excess of pressure on the outside of the instrument. The temperature of the instrument is measured by the apparent volume of the liquid which it contains; hence the effect of pressure is to raise the observed temperature above the true temperature. Parrot and Lenz, in 1832, made a series of experiments on the effect of pressure on thermometers. They experimented at pressures up to 100 atmospheres, and observed differences between the apparent and the true temperatures of as much as 20° C. They found that for the same instrument the compression was simply proportional to the pressure. They used a thermometer as a manometer. After this date it was usual to attempt some kind of protection for self-registering thermometers.

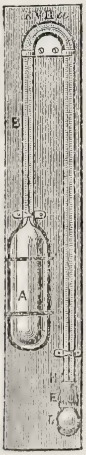
Those with straight stems, such as Walferdin's minimum, were sealed up in glass tubes, and so completely protected. Those whose stems were bent, had to be enclosed in metal cases closed with a screw. This form of protection never answered well, as it was impossible to screw on the cover so tight that the water, under the great pressures met with at considerable depth, would not find its way in. In order not to have to abandon the use of thermometers of the conveninent form of Six's, the device of protecting the bulb only was hit upon, and it appears that the first thermometer of this kind was used by Captain Pullen, on board H.M.S. *Cyclops*. The effect of pressure on the stem is quite insignificant, and under ordinary circumstances, insensible. For, in nearly all seas where the surface temperature is over 40° Fahr., the temperature of the water dimished as the depth increases, and, therefore, it is the minimum leg which is used, and the effective part of it is that filled with spirit, which may have a length of, at most, three inches. The effect of pressure in diminishing the volume of a short piece of thermometer tubing must certainly be very small, but its actual value can only be determined by removing the bulb, and taking the piece of the stem between the mercury and the neck of the bulb as the bulb of a new thermometer, and determining experimentally the effect of pressure on it. An approximation to the effect may be made by exposing the thermometer to various high pressures, at known temperatures, and observing the rise of the maximum index, then removing the bulb, and calibriating the stem. Knowing, then, the ratio of the volume of this part of the minimum leg, filled with spirit to the to the whole volume, from the bulb to the maximum index, it may be assumed that the compression will be in the same ratio. And this value will probably be greater than the real one, for the compression of the water produces of itself a certain rise of temperature, and, consequently, rises the maximum index. This can, however, be estimated, either by a comparison with a completely protected thermometer, or by bringing the minimum index also home on the mercury before raising the pressure. If, then, there has been a rise of temperature caused by compression, there will be a corresponding lowering of temperature on relieving the pressure. If the compression apparatus be allowed to stand after the pressure is up, until it has disiepated the heat evolved by the compression, the relief of pressure will cause a corresponding absorption of heat, which will show itself in the position of the minimum index. Some experiments which I have made in this direction show a lowering of temperature of 0·3° Fahr., for the relief of a pressure of $2\frac{1}{4}$ tons per square inch, the whole rise of the maximum index having been 1·8° Fahr. We may, I think, be quite certain that when the minimum leg is the one used, and the temperature low, the error caused by the effect of pressure on the stem is inappreciable. Cavendish, who invented the self-registering thermometer, foresaw also the most important of the uses to which it could be applied. Thus he suggests that the higher regions of the atmosphere might be investigated by attaching it to a kite—balloons not having been invented. With regard to deep sea explorations, he says:—

"If instruments of the nature above described were to be used for finding the temper of the sea at great depths, some alteration would be necessary in the construction of them, principally on account of the great pressure of the water, the ill effect of which can, I believe, be prevented no other way than by leaving the tube open."

This was written in 1757, and it was not till 1762, as already stated, that Canton proved that liquids are compressible. Cavendish, therefore, hoped that as the pressure would not produce distortion of the glass when the tube was open, it would have no visible effect on the apparent volume of the liquid. The device of leaving his thermometer open at the end was adopted by Aimé in some of his experiments, the effect of pressure on the apparent volume of the

liquid being determined independently, and a correction applied accordingly. I devised and constructed a mercurial thermometer, or piezometer (Fig. 5) on the same principle, but my object in admitting the water pressure to the inside of the instrument, was to utilise it in shifting the scale of the thermometer as the depths changed. The thing registered in such instruments is always the apparent volume of the liquid, and this varies with the temperature and the pressure. Hence the indications will represent the sum of the effects of the change of temperature and of pressure. If from any independent source we know either of these, we can determine the other. In a sea of uniform temperature throughout its depth, the apparent volume of the liquid would diminish as the pressure increased, and if the temperature increased with the depth, the apparent volume of the liquid would diminish at a slower rate; but it would be always possible to determine the true temperature as long as it did not increase at so great a rate as to dilate the liquid more than it was compressed by the increasing pressure. For the investigation of

Fig. 5.



seas such as the Mediterranean, this form of instrument is most valuable. The method of determining accurately both depth and temperature from the combined reading of a mercury and a water piezometer is explained in the paper communicated to the Chemical Society.*

In the great majority of cases, the most convenient instrument to use is the form of Six's thermometer with protected bulb known as the Miller-Casella thermometer, with the following additions and improvements, which Mr. Casella has applied to them at my suggestion:—The size of the instrument is increased so that the degrees are wider apart, a degree Fahrenheit on the minimum leg occupying about three millimetres of its length. Besides the scale of degrees which is attached in enamelled slips to the vulcanite at the sides of the stem, there is an arbitrary (millimetre) scale etched on the stem itself. The valves of the division of this scale are ascertained by a careful comparison with a standard thermometer. It is thus possible to read with certainty to a quarter of a millimetre or a twelfth of a degree Fahrenheit. The errors due to the scale not being rigidly attached to the thermometer, and to the difficulty of determining the height of the index by reference to a scale at the side of, instead of over it, are eliminated. Finally, by having the ordinary scale at the side, the instrument can be used independently of the arbitrary scale, and, even where the arbitrary scale is principally relied on, the scale of degrees enables the observer to know very approximately the true temperature at the moment of observation, without reference to tables, and, by noting on every occasion the reading on both sides, the chance of errors from misreading is greatly reduced. The maximum leg, which is only rarely used, is of larger bore than the minimum one; the degrees, therefore, are closer, and the temperature of the instrument may rise as high as 100° Fahr., without the index entering the terminal bulb. This is a detail of considerable practical importance, for it is impossible always to protect the therometers, when on deck, from the direct rays of the sun, which would speedily disable the maximum side of the thermometer, if its range were as limited as that of the minimum one.

It will be seen, from what has been said, that there is no one instrument which fulfils all conditions required of a perfect deep-sea thermometer. It is necessary, therefore, for the investigator to use his judgment in the selection of the instrument best suited for the particular case before him. In order to be prepared for possibly occurring cases, he should be provided with thermometers of (*a*) the Miller-Casella type, with improvements just described; (*b*) the mercury piezometer, (*c*) the Negretti and Zambra inverting thermometer. It is well to have several of the first class (*a*), as any number of them can be attached to the line at different depths, and thus much time saved. In my own practice, I generally use four or five at a time. It is not advisable to exceed this number, as the loss in case of accident would be too heavy. Considering the distribution of temperature actually found in lakes and seas of warm and temperate regions, this is the most generally useful instrument, when thorough investigation by means of series of observations is intended. In the particular and frequently occurring case of an enclosed sea, containing a large mass of water, showing no variations of temperature when tested by this instrument, it must be replaced by the mercury piezometer (*b*), which possesses the advantage that the position of the thermometric scale shifts along the stem according as the depth varies. Also, any number of them can be used at the same time at different depths on the same line. The inverting thermometer of Messrs. Negretti and Zambra (*c*) is the instrument most suitable for isolated observations. It is also of very great use for supplementing and controlling the observations with the other instruments, especially in the case of sea lochs or fjords, where the temperature distribution is often much disturbed by the imperfect mixture of fresh with salt water.

For the successful and expeditious carrying out of deep-sea temperature observations, the investigator should be furnished with improved Miller-

* "Journal of Chemical Society," October, 1878. The blocks of Figs. 2, 5, 6 have been kindly lent by the Council of the Chemical Society.

Casella thermometer for the bulk of the work, and the mercury piezometer and the investing thermometers for particular cases. All the thermometers, of whatever type, should be carefully compared with a good standard, and the results stated in terms of its scale.

For the determination of the specific gravity of the water, it is necessary to have an instrument of considerable delicacy, which can be used in all moderate weather at sea. The specific gravity of a liquid is ordinarily determined in one of two ways, either with the specific gravity bottle, when the weight of a known volume of the liquid is directly observed, or with the hydrometer, when the volume of a known weight is observed. A special modification of the hydrometer, namely, specific gravity bulbs, has long been in use for special purposes, and they have been used by Dr. Carpenter and others for sea-work. The only objection to their employment, in work of purely scientific interest, is that each bulb, being in effect a separate hydrometer, has to be separately tested for its weight and volume, and for change of apparent density with changes of temperature. With the large number of bulbs which is necessary, this involves an enormous amount of labour expended, without corresponding advantage. Sets of hydrometers, graduated so as to include all specific gravities naturally occurring in the sea, have been used. When each hydrometer has been constructed of the requisite delicacy, and of workable proportions, it is necessary to have a set of ten hydrometers; and the same objection obtains as in the case of the bulbs. For the work of the *Challenger*, an instrument of suitable size and proportions was constructed. Its stem carried an arbitrary scale (millimetres), and was very carefully calibrated; the weight of the whole instrument was also carefully determined, and also the dilatability of the body. The instrument was entirely of glass. By a contrivance similar to that used in Nicholson's hydrometer, weights could be placed on the upper sub-cavity of the stem. By this means the range of usefulness of one hydrometer can be extended far beyond the limits occurring naturally in the sea.

In prosecuting independently this work, I have improved on some of the details of the instrument, without, however, in any way altering its general character. In the *Challenger* instrument, the body was a cylinder, containing about four diameters in its length; in the heavier form it is a sphere of about the same volume, this materially reducing the length of the instrument. Instead of a small brass table, and weights to be laid on it, the weights are hollow brass cylinders, closed at one end, and widened to a flange at the open end with others in the form of flat rings, which can be slipped over the cylindrical weights, and then rest on the flange. These are small mechanical details, which, however, greatly affect the handiness of the instrument, and they are therefore of importance. The following is a description of the instrument used for the whole of the work done during the cruise of the *Challenger*. The stem, which carries a millimetre scale 10 centimetres long, has an outside diameter of about 3 millimetres, the external volume of the divided portion being 0·8607 cubic centimetre; the mean volume of the body is 160·15 cubic centimetres, and the weight of the glass instrument is 160·0405 grammes. With this volume and weight, it floats in distilled water of 16° C. at about the lowest division (100) of the scale. In order to make it serviceable for heavier waters, a small brass table is made to rest on the top of the stem, of such a weight that it depresses the instrument in distilled water of 16° C. to about the topmost division (0) of the scale. By means of a series of six weights, multiples by 1, 2, 3, 4, 5, and 6, of the weight of the table, specific gravities between 1·00000 and 1·03400 can be observed. It is not necessary that these weights should be accurate multiples of the weight of the table; it is sufficient if they approach it within a centigramme, and their actual weight be known with accuracy. The weights of the table and weights in actual use are:—

Weight of table		0·8360	grammes.
Weight of weight No.	I.	0·8560	,,
,, ,,	II.	1·6010	,,
,, ,,	III.	2·4225	,,
,, ,,	IV.	3·1245	,,
,, ,,	V.	4·0710	,,
,, ,,	VI.	4·8245	,,

For oceanic waters, the hydrometer is always used with the table, and either No. IV. or No. V. weight.

When the mechanical part of the construction of the instrument was finished, with the exception of the closing of the top of the stem (which, instead, was widened into a funnel-shape, large enough to receive the ordinary decigramme weights), the calibration of the stem was effected by loading the stem with successive weights, and observing the consequent depressions in distilled water of known temperature. This done, the top was sealed up, and the instrument carefully weighed. The expansion of the body with temperature was determined in a similar manner, by reading the instrument in distilled water of various temperatures. The co-efficient of expansion of the glass was then found to be 0·000029 per degree Centigrade.

For using this instrument at sea, about 900 cubic centimetres of sea-water are taken, and the containing cylinder placed on a swinging table, in a position as near the centre of the ship as possible. The observation with the hydrometer, loaded with the necessary table and weight, is then effected in the ordinary way, the accuracy of the readings being but little affected by rolling; pitching, however, is found to have a distinctly disturbing effect; and when it is in any way violent, it is advisable to store the specimen of water till the weather improves.

The temperature of the water at the time of observation is determined by one of Geissler's "Normal" or standard thermometers, graduated into tenths of a degree Centigrade; and it is essential for the accuracy of the results that the water, during the observations of the hydrometer, should be sensibly at the same temperature as the atmosphere, otherwise the changing temperature of the water makes the readings of both the hydrometer and the thermometer uncertain. At low temperature (below 10° or 12° C.) a tenth of a degree makes no sensible difference in the resulting specific gravity; but, at the high temperatures always found at the surface of tropical seas, rising sometimes to 30° C., the same difference of tempera-

ture may make a difference of three to four in the resulting specific gravity.

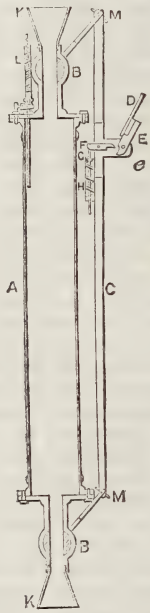
Having obtained the specific gravity of the water in question, at a temperature which depends upon that of the air at the time, it is necessary, in order that the results may be comparable, to reduce them to their values at one common temperature. For this purpose a knowledge of the expansion of sea-water with temperature is necessary.

This had been determined with sufficient accuracy for low temperatures by Despretz and others; but as the temperatures at which specific gravity observations are usually made are comparatively high, their results were of but little use, directed as they were chiefly to the determination of the freezing and maximum density points. When the late Captain Maury was developing his theory of oceanic circulation, owing to difference of density of the water in its different parts, he found the want of information on this important subject. At his request the late Professor Hubbard, of the National Observatory, United States, instituted a series of experiments, from which he was enabled to lay down a curve of the volumes of sea-water at all temperatures, from considerably below the freezing point to much above what obtains even in the hottest seas. The results are published in Maury's "Sailing Directions," 1858, vol. i., p. 237, and have evidently been carried out with great care. The composition of different oceanic waters varies, even in extreme cases, within such close limits, that the law of thermal expansions is sensibly the same for all of them; of this, Hubbard's experiments afford satisfactory proof. In the table which gives the results of all his experiments, he takes the volume of water at 60° Fahr. as his unit. In order to avoid much useless calculation, I have been in the habit of reducing my results to the same temperature (15·56° C.), while, for a like reason, I have retained the specific gravity of distilled water at 4° C. as the unit. The choice of a common temperature, to which the results should be reduced, and of a unit of specific gravities, is a purely conventional matter; and in choosing the above-mentioned ones, in the first instance, I was moved solely by a desire to save calculation. For every water, however, there is one temperature to which it would be natural to reduce its specific gravity, namely, the temperature which the water had when in its place in the ocean; and in this sense all my results during the cruise have been reduced. Hubbard's table of the change of volume of a mass of sea-water, with change of temperature, enables us very easily to reduce any observed specific gravity from the temperature of observation to any other temperature, say 15·56° C.

Collection of Samples of Water.—The water from the bottom was usually collected in the so-called "slip" water-bottle, which has been described by Professor Jacobsen. Water from intermediate depths is obtained in an instrument represented in section in Fig. 6. It is made entirely of brass, which, however, might advantageously be nickel-plated. It consists of a cylinder, A, terminated at both ends by similar stop-cocks, B B, which are connected by the rod, C. This rod carries, near its upper extremity, a piece of stout sheet brass, D, 10 centimetres long by 15 broad, soldered to the casting, E, which is movable about the axis, *e*. The function of this part of the apparatus will be more easily explained by describing the manipulations necessary when collecting water.

When intermediate water is to be obtained, the water-bottle is firmly attached to the sounding-line, which carries at its end usually a 56 lb. or 1 cwt. lead; the stop-cocks are then opened, giving

Fig. 6.



them, with the rod, C, the position represented in the figure. The line is then lowered carefully by hand, until the water-bottle is close to the surface, when it is let go, and the line allowed to run out without a check. During its passage downwards, the water courses freely through it, being considerably assisted by the conical end pieces, K, K. When the requisite depth has been reached, the line is checked again at the same mark, and finally hauled in altogether by the donkey-engine. When the line is hauled in at first, the flap D falls down into a horizontal position, when it is caught by the movable piece of brass, F, which moves round an axis, *f*, and is supported on the side opposite to E, by the rod, G, which rests on the spiral spring, H. The water rushing past D, when thus in a horizontal position, exercises a sufficient pressure upon the rod to close the stop-cocks, B, B. When the speed with which the bottle is hauled through the water is increased, the pressure on D becomes so great, that it overcomes the tension of the spring, H, and E passes the catch, F, when the rest of the journey upwards is performed with the flap, D, hanging down, and therefore offering the least possible resistance to the water. The object of at first hauling in only a couple of fathoms or so, and letting the line go again, is to ensure the cocks being closed. For, supposing after the first hauling in they were not quite closed, by letting the instrument descend through the water, the flap, D, sets itself again, and, on heaving in, it shuts down the stop-cocks, which were before but partially closed; or, if they were

closed before, it only shuts them the tighter. When the water-bottle has been brought up, it is only necessary to substitute for the lowermost brass funnel a small nozzle, when the water may be tapped into any vessel destined to receive it. This done, the bottle may be at once lowered to any other required depth, much time being spared by not having to detach it each time. At the upper end of the bottle a small spring safety valve, I, is introduced, in order that the considerably denser water from below may be able to make room for itself as the surface is approached. In order that the instrument may properly do its work, it is evident that, first, the stop-cocks should be so stiff that the weight attached to their levers be not sufficient to close them; and, secondly, the spring, H, should be so strong as to ensure the shutting of the cocks before it itself gives way. These conditions are secured by the following means of adjustment. The stop-cocks can be made stiff in the usual way, by lightening the screws which screw the "keys" in the bands; the tension of the spring, H, can be increased or diminished by means of a screw at the lower end of the tube containing it; and the mobility of the stop-cock can be regulated by means of the screws, M M. Although from this description, the operations of adjustment may appear complicated, it is, in fact, practically very simple. After the first time of use, it is rare that any further adjustment is required than a turn of the screws, M M. The diameter of the apertures at either end is necessarily smaller than that of the the cylinder; it is, therefore, impossible for the water in it to be entirely changed while descending through a distance equal to its own length. It became a question, therefore, for experiment to to decide what actually was the rate of change of water. To this end, a few experiments were made in a fresh-water lake. The bottom being filled with water containing some yellow prussiate of potash, was sunk in the lake, until the surface of the water was on a level with the upper stop-cock, when the stop-cocks were opened, and the line let go. On being brought up again, the contents were treated with the solution of perchloride of iron. It was found that, when the bottle had been sunk to a depth of a fathom and a-half, the water had been entirely changed, the iron solution being wholly without action on it. We may be certain, then, that the water which we obtain by this means is an average of the last two fathoms through which the bottle has passed.

The weight used as a sinker should be chosen so as to impart sufficient velocity not to lose time unnecessarily over the operation, and, at the same time, not to give an excessive velocity at the depth where the water is to be collected, because the rate of change of water depends on the friction of the water inside the bottle, and so on the velocity of descent. In practice, for depths over 100 fathoms, a weight of 112 lbs. was used, and for depths from 25 up to 100 fathoms, a weight of 56 lbs. was used. For less depths the weight of the bottle itself was sufficient, The velocity of descent at the depth where the water is to be collected should not exceed 12 feet per second. The mean velocity for the interval between 75 and 100 fathoms from the surface was, with 66 lbs., nine feet, and with 112 lbs., eleven and a-half feet per second.

When once let go, it is essential that the line should run out to the required depth without a check; it is then, however, immaterial, as far as the water bottle is concerned, what interruptions occur in heaving in. The fulfilment of the condition of running out without a check never presented any difficulty on board the *Challenger*, depending as it does on the care of those who take the line. When, however, by accident a check does occur, the line is stopped, and the water-bottle brought up again, reset, and sent down again. In order to utilise any such accidents, it is usual to take the water from the greatest depth first; then, if a check does occur, it may occur at one of the desired intermediate depths, and so no time would be lost. In designing the water-bottle, it had been my intention to use it not only for collecting water, but also as a flask, so that the atmospheric gases could be boiled out of it without transvasing the water. In practice, however, I have not been able to get air-tight stopcocks, besides which, it would make an inconveniently large apparatus in a very small laboratory. I have spoken of this water-bottle as being only used for intermediate waters, but there is no reason why it should not be used for bottom water; indeed, where the sounding lead does not weigh over 1 cwt., it is frequently used for this purpose. In the case of deep soundings, however, where a weight of three, and sometimes four hundred-weight is used, the "slip" water-bottle is always preferred.

DISCUSSION.

A Member asked how the depth of the mud at the bottom of the sea was determined; and how the instruments would be affected by it, because when the instrument touched the soft mud, it would not act as it would if the ground were hard.

The Chairman said that having been Commander of the *Challenger*, it was scarcely necessary to say how important he considered the subject on which Mr. Buchanan had been speaking. It was most important for telegraphic purposes to know not only the depth of the sea, but its properties. The *Challenger* expedition had been found fault with for not adopting at once the present system of sounding, dredging, and taking temperatures; but all these things were progressive, and, thanks to Sir William Thomson and the telegraphic companies who were also interested in these matters, and to Mr. Buchanan who was working at it independently for the love of the thing, satisfactory progress had been made. They were pretty well satisfied with the present apparatus for sounding, for which purpose they now all used wire, because they could get the sounding so quickly. In fact, when laying telegraphic cables, a second ship, with a wire-rope and lead 35 lbs. in weight, could follow and measure the depth every 20 or 30 miles as they went along, and keep up with the one paying out the cable at the rate of five or six knots an hour. In taking serial temperatures, great care was required, because the thermometers were so valuable—not exactly in themselves, although they were very delicate instruments—but because on the return of a ship after three years' work, the thermometers which had been used in those observations were worth any amount of money for reference in future, their errors having been determined. At present, therefore, they had not sufficient confidence in wire-rope for temperature soundings. As regards dredg-

ing, they now learned that telegraph ships had given up the wire-rope for picking up old cables, on account of the weight; so that at present wire was only used for soundings. The United States Government, in their operations in the Gulf of Mexico year after year, had attained a very high state of perfection. The English dredges were just bags which scooped up a cargo of mud, and could not be scraped along the bottom. But the Americans had improved upon that, and had an iron frame, in the form of a parallelogram, which was far more successful. The great desideratum now was, not to sound quicker, but to attain more exactness. As to temperature, they had got to the decimal part of a degree, which was near enough, but they wanted more information as to the movement of the water at the bottom. All the measurements as yet taken in connection with ocean currents and tidal movements, were on the surface; but there was a great deal of movement at the bottom, and a knowledge of it was very requisite, especially for telegraphic purposes. The motion caused by a heavy sea was not supposed to extend more than 40 or 50 fathoms down, but telegraphic cables wore out at depths of from 300 to 400 fathoms, so that there must be motion going on down there. The barrier across the entrance to the Mediterranean was about 200 fathoms, or 1,200 feet, and water below that level did not get into the Mediterranean. If you sank a thermometer, it showed the same temperature at 200 fathoms as at 2,000, so that the bottom water did not move at all. In the Atlantic or Pacific, if a thermometer denoted that the temperature of the sea got colder and colder as the depth increased, it showed that in such places there must be an enormous movement of cold water, probably from the Poles, that cushioned up against the barriers, and got stopped. The great desideratum now, therefore, was an apparatus to denote the movement of water at different depths. With regard to the temperature of the mud at the bottom, when Sir Wyville Thomson and other gentlemen were sifting out the mud for shells and minute organisms, no matter whether they were on the equator or elsewhere, their fingers were nearly frostbitten, and it was a constant practice to cool the wine by putting the bottles in this mud. A thermometer with a wooden case, such as had been shown, if sunk to the depth of a mile, would have the whole of the air in the pores of the wood squeezed out; afterwards it would sink at once in water, if immersed. Between New Guinea and Australia, the trawl often came up literally full of wood and leaves from the bottom, which must have become water-logged by the same means. In fact, there was a coal formation going on at the mouth of some of these rivers, which were not carrying down soil enough to cover the leaves and wood, which, as they got thoroughly soaked, sank, and kept sinking as they became more dense from the pressure of water, until they reached the bottom. It had been supposed that the water got gradually colder and colder as the depth increased; but in the Antarctic region, he felt perfectly certain that they tapped a stratum of warm water under the cold, though they could not measure it. He wrote home from Australia for such a thermometer as Mr. Negretti had now arranged. In the Antarctic regions, whether from the greater density of the water or from some other reason, there was a cold stratum at the top, then a warm stratum, and then a cold stratum again underneath. Similar observations were required near the North Pole also, but after all, the great desideratum at present was a method of obtaining observations of submarine currents.

Mr. Buchanan, in reply to the question as to the effect of mud on the sounding instruments, said that water bottles was so delicately slung, that the least support would tumble off: they did sometimes come up full of mud instead of water, but very rarely. He never remembered a failure from the sounding weight not slipping. The only difficulty with the water bottle was that now and then it would choke itself by the cord slipping the wrong way, but that very seldom occurred.

The Chairman then proposed a vote of thanks to Mr. Buchanan, which was carried unanimously.

INDIAN SECTION.

Friday, March 4, 1881; Sir Richard Temple, Bart., G.C.S.I., D.C.L., in the chair.

The Chairman said, in introducing Mr. Maclean to the meeting, that he thought he could promise they would have a paper both agreeable and instructive. He had known Mr. Maclean in India, where he had been considered—and justly considered—an ornament of the press. He wished there had been a somewhat larger audience on the present occasion, but though not large, it was select. And he must remind the reader of the paper that, through the *Journal* of the Society, he had an appreciative and influential audience of between 3,000 and 4,000 members.

The paper read was on—

THE RESULTS OF BRITISH RULE IN INDIA.

By J. M. Maclean.

Perhaps no question has been more hotly debated of late years than the value to the people of either country of the political connexion established between England and India. In less enlightened ages the benefits derived by the ruling nation, at all events, from an extended empire, were considered to be too manifest to require discussion; and while, a century ago, the American colonies, which revolted from Great Britain, gained some champions of the justice of their cause even in the British Parliament, the science of political philosophy was then so undeveloped, that statesmen of all parties agreed in deploring, as a national calamity, that separation which is applauded by certain Englishmen in our own day as one of the greatest blessings that could have been conferred upon this country. On the Continent of Europe, the old-fashioned view of the advantages to a State of Imperial dominion still holds its ground among the most advanced thinkers. I need hardly remind you, for instance, of the opinion expressed by De Tocqueville, in 1857, that it was the possession of India which secured to England the immense consideration she enjoys throughout the world, and that the loss of her great dependency would be quickly followed by her decline to the rank of a second-rate power. In England, however, a modern school of political essayists, who pride themselves on their superiority to vulgar prejudice, are fond of maintaining the paradox that the abandonment of India by the English would increase the power and resources of this country. What is morally wrong, they argue, can never be politically right; and they are continually vexed with such uneasy questionings of conscience as to the justifiableness of England's conduct in holding a foreign country in subjection, that they eagerly ascribe to it all kinds of evil consequences. Their way of thinking in this matter is like that of a distinguished Envoy from China, who on his voyage to Europe asked the captain of

the Peninsular and Oriental steamer in which he was a passenger to spread out before him the map of the world, and show him what territories belonged to England, and who, after having had our colonies and dependencies in Europe, Asia, Africa, America, and Australasia pointed out to him, held up his hands in amazement, and exclaimed, "Well, I am astonished that Heaven does not inflict some heavy punishment on such a nation of land robbers." But they believe that our insatiable lust for new possessions has brought with it its own punishment, and that, while England has ruined India materially by dragging her to the brink of bankruptcy, India has, in her turn, demoralised the English people, by infecting them with a base desire for power and glory, instead of a pure love of liberty. Probably many Anglo-Indian officials, after reading in some impassioned paper on the mischief of keeping India, a fervid description of their own pernicious influence in corrupting English society, must have been able to realise what Warren Hastings felt when, at the close of Burke's speech for the prosecution, on his trial at Westminster-hall, he said he was persuaded he must have been a great villain, though he never knew it before. The only consolation they can have is in the reflection that these essays are, for the most part, written by young men, whose ambition to win a name as philosophical critics leads them to seize upon a taking subject, with which they have no practical acquaintance, and that the gloomiest pictures of the disastrous effects of British rule in India are painted by persons who have never set foot in that country, and who have little or no acquaintance with the real character of the English civilians and soldiers by whom it is governed. What wonder is it if the extravagance and unfairness of such attacks excite a vehement and sometimes unreasoning opposition, or that irritated Anglo-Indian officials set their faces as one man against outside criticism, and vie with one another in emphatically asserting that theirs is the best of all possible administrations? Hence we have, on the one side, high-flown rhetorical criticism which overshoots its mark, and, on the other, a prejudiced determination to defend, at all points, a system of government in which the candid observer cannot fail to detect numerous imperfections. My aim this evening—and I do not conceal from myself the hazard I run through interfering as a neutral in such a quarrel—is to steer a middle course between these two extreme parties, and, while attempting to give you good reasons for repudiating the doctrine that English rule in India has had purely mischievous results, to offer some practical criticisms on administrative defects, the existence of which is denied or overlooked by official optimists.

It is hardly necessary to insist upon the obvious material gains which accrue to England from the possession of an Eastern Empire. A simple enumeration of them will suffice. In the first place, it is no slight advantage to us that the Government of India disburses in this country about 16 millions sterling a year, out of the revenues collected from Indian taxpayers. The English nation, it is true, does not take this money from the people of India without giving them something in exchange for it. The amount of the home charges represents the value of munitions of war, commissariat stores, and railway materials sent out to India, interest on English capital invested in that country, and payments for skilled English labour employed in the Indian civil and military services, or in the construction and superintendence of public works. But, for a country which has a good deal of capital and skilled labour to spare, as England has, it is an unquestionable advantage to find such safe, constant, and profitable means of investment; and we have only to contrast the security enjoyed by the holders of Indian bonds, and the public servants of the Indian Government, with the anxieties and losses endured by Englishmen who have trusted in the good faith of other Eastern States, to get a measure of the pecuniary worth of our imperial supremacy. But the home charges only show the direct transactions between the Governments of England and India. The indirect gains of private enterprise in India are also very considerable. British India ranks now with France, Germany, and the United States among our very best customers. The United Kingdom supplies her with three-fifths of her whole imports of merchandise; and, while there were not wanting a year ago prophets of evil, who exulted over the falling away in the Indian trade, consequent on the famine of 1878, as evidence of the accuracy of their gloomy forebodings, and who predicted that it could never revive, but must continue to decline, it is satisfactory to observe that there was an immediate rebound after the good harvest of 1879, the imports of merchandise, in the year ending March 31, 1880, having exceeded those of the preceding year by more than three millions sterling, while for eight months of the present financial year, April to November, 1880, not only was this re-action maintained, but the imports of merchandise increased in value to 32 millions, against 24 millions in the corresponding period of 1879, showing a further rise of 25 per cent. Nor do Englishmen make profits only on the import trade into India.*

* Trade of British India, exclusive of Government Stores and Treasure, on account of Government.

	Year ending March 31, 1879.	Year ending March 31, 1880.
	£	£
Imports:—		
Merchandise	36,566,194	39,742,166
Treasure	7,056,749	11,655,395
Total....................	43,622,943	51,397,561
Exports:—		
Merchandise	60,893,611	67,173,158
Treasure	3,895,545	1,928,828
Total....................	64,789,156	69,101,986
Total Imports and Exports, Private Trade ..	108,412,099	120,499,547

Eight Months, April to November, 1880.

Imports:—	
Merchandise	£32,069,340
Treasure..................	6,462,616
Total	£38,531,956

Exports:—	
Merchandise	£44,306,012
Treasure	1,036,127
Total	£45,342,139
Total Imports and Exports for eight months of 1880-81	£83,874,095

STATEMENT SHOWING THE AMOUNT OF BILLS DRAWN ON INDIA DURING THE FOLLOWING PERIODS, AND THE SUMS RECEIVED IN RESPECT THEREOF:—

Period.	Bills Drawn.	Sum Received.		
	Rupees.	£		
1878-79	169,123,612	13,948,565		
1879-80	183,500,000	15,261,810		
1880.		£	s.	d.
April	21,500,000	1,786,783	1	10
May	14,000,000	1,167,621	2	0
June	16,500,000	1,387,041	2	11
July	12,000,000	1,009,572	18	7
August	12,000,000	1,011,406	5	3
September	15,000,000	1,254,122	19	3
October	12,000,000	1,000,270	16	10
November	12,000,000	990,078	3	1
	115,000,000	9,607,596	9	9

The greater portion of the export trade from India is also controlled by English houses, settled in the Presidency towns; and four-fifths of the shipping engaged in the foreign commerce of India belong to British owners. If you trace the history of a bale of Indian cotton, exposed for sale in the Liverpool market, you will probably find that in all its successive stages, after being grown and picked by the native cultivator, it has been made ready for and brought to the market by English capital and labour. An English agent has selected it in the producing district; it has been carried down to the sea-coast by a railway company working with English capital; an English mercantile firm in Bombay has pressed it, and sold the bill of exchange against it through an English broker to an English bank; and it has been transported from Bombay to Liverpool on board an English steamer. So, again, with regard to the piece goods trade from this country, it is entirely financed and managed by Englishmen till the bales pass into the hands of the native dealers in the bazaar of Bombay. You will readily calculate how many different profits this vast trade, which may be valued at a hundred millions sterling, yields to all these classes of English manufacturers, merchants, bankers, middlemen, shippers, engineers, and other mechanical experts. And when you add to such mercantile gains the private remittances sent home by English tradesmen and professional men settled in India, and by the civil and military servants of the Crown, you can realise how immense, in the aggregate, must be the contributions which our great dependency annually makes to the wealth of England. There is not a town, it may be said without exaggeration that there is not even a hamlet, in this country in which the fructifying influence of the capital thus acquired is not felt, although it may not be always recognised; and I do not know any industry in the United Kingdom, small or great, which would not suffer loss, if the connexion with India were broken off. But, it may be urged, our profitable trade with India would remain, even if that country became independent. I deny that it could remain. The preference for indirect over direct taxation, which is common to all except the most enlightened nations, and which is even shared by many Englishmen, is only counteracted in India by the authority of the Imperial Government; and, if this were once removed, the natives would speedily raise a large proportion of the State revenue by levying protective customs' duties on piece goods and other English merchandise, and would injure our carrying trade by granting bounties to native shipping. The impress, too, of English civilisation, which is now modifying native customs and manners in the great cities at least, and creating a taste for the comforts and refinements of European life, would soon be effaced, and a limit thus set to any possible extension of our trade in the East. I cannot but conclude, therefore, that the material interests of England are bound up with the maintenance of our Indian Empire. Whether or not the possession of empire is morally beneficial to the citizens of a free State is a more delicate and disputable question. It is many years now since the republican virtue of Professor Goldwin Smith took alarm at the liking for arbitary government which he detected in the large and increasing body of retired Anglo-Indians. So far, however, as my own experience goes, I think I may say that Anglo-Indians generally hold very liberal views about matters of domestic policy in England, and are rather inclined to make light of the controversies about franchises and Burial Bills, which, if we are to believe excited party politicians, periodically bring this country to the brink of a revolution. It is quite true, on the other hand, that Anglo-Indians are, perhaps to a man, Imperialists in the best sense of that much-abused term; and possibly in the present temper of the public mind, it is not to be regretted that a strong infusion of Imperialism should be poured into England year by year, from her colonies and dependencies in all parts of the world. For the imperial instinct is always active in young and vigorous nations; it is nowhere keener or more energetic than in the United States of America; and an observant companion of General Grant in his recent voyage round the world, paid Anglo-Indians what he took to be the high compliment of remarking that, in their political character, they seemed to him to resemble Americans rather than Englishmen.

I pass now to the consideration of the more difficult branch of my subject—the effect, namely, on the fortunes of the people of India of England's relations with that country. Is it the case that the alliance between the two nations is mutually advantageous, or are all the benefits of it enjoyed by one, while the other suffers the loss, not only of its political liberties, but even of the legitimate rewards of industry, and the natural increase of the fruits of the earth? It is not too much to say that India is believed by many Englishmen—such is the force of persistent misrepresentation—to have been brought to the brink of ruin by the imperial bur-

dens mercilessly imposed upon her. The phrase, "The Bankruptcy of India," is often used as if it described an actual fact, instead of the vision of an overwrought and distempered imagination. The English peace established throughout India is declared to be as baleful as the *Pax Romana* was to some of the provinces of the Roman Empire; but the reproach addressed by the Roman historian to his countrymen, *Solitudinem faciunt, pacem appellant*, does not apply in this case. England's crime, on the contrary, appears to be that, under her rule, the Indian population has multiplied too freely for the productiveness of the soil; that the yearly drain of wealth to England has so impoverished the country, as to leave no margin of the means of subsistence stored up against the years of famine which recur at regular intervals; and that, consequently, when a scarcity comes, the people, taxed to the utmost limit of human endurance, perish by millions, because they have neither food enough at home to eat, nor the money wherewith to purchase it abroad. English Imperialism is, in fact, we are told, killing itself by the exhaustion of its victim. Well, this gloomy picture must strike with amazement anyone who is familiar with the outward signs of the steadily increasing prosperity of India. Can it be possible that a revenue steady in growth and easy of collection, that populous and wealthy cities, a flourishing foreign trade, the rapid development of many new industries, and a general rise in the standard of living among the labouring classes of the population, which are the accepted marks of well-being in all other States, only conceal in India a deep-seated disease which is wasting away the body politic? Let us examine attentively the statistics of trade on which the believers in India's impending ruin chiefly rely. I have already shown you how profitable this trade is to England, but we are told that it must be in an equal degree unprofitable to India, since that country, according to the Custom-house returns, exports every year twenty millions' worth of produce, for which she gets nothing back. The fallacy of this argument lies in the assumption that the Custom-house returns afford a complete balance-sheet of the transactions between the two countries. To find out what India really gets in exchange for her exports of produce, you must add to her imports of merchandise and treasure so many millions for interest on English capital invested in India in a hundred different ways, and so many more for the wages of the skilled English labour employed in her service; and when these additions have been made to the valuations of the Custom-house authorities, India is found to be no loser by her foreign commerce.

This conclusion is further borne out by an analysis of the kind of imports she receives. She does not, as a poor country necessarily would do, take back the value of her exports of cotton, indigo, seeds, tea, coffee, and spices in food and clothing for her people. She imports what foreign merchandise she requires, and is paid the balance in gold and silver. Mr. Goschen's Committee of 1876, on the depreciation of silver, calculated that, in the 40 years between 1835-36 and 1874-75, India absorbed, in round numbers, silver to the amount of £200,000,000, and gold to the amount of £100,000,000. The whole of this gold, and probably the greater portion of the silver, were manufactured into ornaments or hoarded. Since 1876, when the opinion generally prevailed that a steady decline had begun in the Eastern demand for bullion, the imports into India have continued on the same scale, and it is not a little remarkable that in the famine year, 1877-8, they amounted to the sum, unprecedented since the era of the American civil war, of more than £15,000,000. Now it is surely preposterous to assert that a country, which is thus shown to be at the present day, as it has been for many centuries, "the sink of the precious metals," can be falling more deeply every year into a state of hopeless poverty.

But, it may be said, granted the unreality of the supposed drain of wealth from India, and that the larger amount of capital now devoted to agriculture, and the increased facilities of communication, give her a surplus stock of produce by the sale of which to foreign nations she can steadily enrich herself, still the question remains, if the wealth thus acquired is fairly distributed among the people, and especially among the cultivators of the soil. There must be something rotten in the state of any country in which wealth accumulates in a few hands, while the mass of the population become poorer every day. Now, a very strong opinion has recently been expressed by Mr. James Caird, who, as a great authority on agriculture, was nominated by the late Government a member of the Indian Famine Commission, that, "so far, our success in India has resulted rather in the conquest of vast possessions, than in elevating the individual man." The cultivator is, as a rule, he thinks, the slave of the money-lender. It is not, however, denied that the stock of capital available for investment in agriculture has increased, or that there is a steady extension of cultivation. If, nevertheless, the condition of the actual cultivator in some parts of the country has deteriorated, the cause of this decay must be sought in the habits of the people. The tendency of modern trade is to sweep away the middleman, by bringing the ryot, or peasant proprietor, into direct communication with the European markets, and thus enabling him to make larger profits on the sale of his produce; but no change of this kind can permanently benefit small holders, who have no money of their own, who think it a mark of respectability to be deep in their bankers' books, and who, by an honourable custom, make themselves responsible for their fathers' debts. The ryots of the Deccan had a magnificent opportunity of making themselves and their families for ever independent of the village usurer during the five years of the American civil war, when the price of Indian cotton was more than quadrupled. But they fancied, as the Bombay Government did, that this exceptional period of prosperity could be maintained; and so, while they, on the one hand, exercised no thrift, the Government, on the other hand, raised their rents, until, in the long period of falling prices which succeeded the American war, their situation became intolerable. The remedy sought by the Government for this state of things is the limitation of usury; but there can be no more grievous economical mistake than, in the hope of averting political mischief, to root an impoverished peasantry in the soil, and drive capital away from cultivation. But Mr. Caird goes on to say that the condition of

"the landless labourer" is still more deplorable than that of the cultivator. "Though wages have risen at the centres of industry, this is not the case in the purely agricultural parts of the country. In such localities the labourer gets the same dole that he got in the last generation. The numbers of such people are increasing, and their condition is becoming every ten years more desperate. Thus, the greatest difficulty with which the Indian statesman is confronted is over population, with constant increase, and his first and main duty will be to carry out a policy under which the people may be enabled to provide themselves with food. An exhausted agriculture and an increasing population must come to a dead lock." Elsewhere he says, "Population is increasing, the price of food is rising, the production of it, as shown by exports, scarcely advances; whilst, as the number of the landless class who depend on wages is constantly growing, the supply of labour, in the absence of industries other than agriculture, must soon exceed the demand. Already their wages bear a less proportion to the price of food than in any country of which we have knowledge. The common price of grain in the Southern States of America, on which the free black labourer is fed, is the same as that of the Indian labourer, viz., 50 to 60 lbs. the rupee. But his wages are eight times that of the Indian, 2s. to 2s. 3d., against 3d. a day, whilst the climate is much the same in its demands for clothing and shelter." The reply of the Government of India to this formidable indictment is an admission that "the population of some parts of India is very dense, especially in the Ganges Valley, from Saharanpur, in the north-west, to Tipperah, in the south-east," and that it is "in some parts, already too thick for the country and its produce." At the same time the Government maintains what, in face of this admission, would seem to be the paradox, that wages have risen in India during the last 20 years. The wages of skilled labour of all kinds have risen considerably, but even the wages of rural labourers show a distinct improvement." Dr. W. W. Hunter, in his recent lectures, seems to take almost as unfavourable a view of the case as Mr. Caird does. Speaking of the increase in numbers of the inhabitants of British India, he says:—

"The average population is now 211 to the square mile. How thick this population is may be realised from the fact that fertile France has only 150 persons to the square mile; while even in crowded England, wherever the density approaches 200 to the square mile, it ceases to be a rural population, and has to live, to a greater or less extent, by manufactures, mining, or city industries. Throughout wide districts in India, each acre of land has to feed a human being for a year. In certain smaller areas of Bengal, two persons have to live on the produce of each cultivated acre, or 1,280 persons to the cultivated square mile. We speak of the poverty and the miserably small farms of the Irish peasant. Well, Ireland has, according to the last census, 169 persons to the square mile. But we can take 13 districts of Northern India, equal in size to Ireland, which have to support an average of 680 persons to the square mile, or over one person to each acre."

I venture to protest against the tone of exaggeration which pervades criticisms of this sort. The average population of Belgium to the square mile is 451; of England and Wales, 389; of Saxony, 377; of the Netherlands, 291; of the Chinese empire, 289; of Great Britain and Ireland, 265; of Wurtemberg, 249, and of Italy, 237. India, therefore, is very far from topping the list, and Germany, with a population of 193 to the square mile, treads very closely on her heels. But the superabundant population of India is mainly to be found in the broad valley of the Lower Ganges, which possesses a soil of unrivalled fertility, and is capable of maintaining probably twenty times the population that could live upon an equal area of territory in the German Empire. Dr. Hunter declares that, "after a minute comparison of the condition of the Bengali peasant in our own times with the facts disclosed in the old manuscript records, he is compelled to the conclusion that, throughout large areas, the struggle for life is harder than when the country first passed into our hands." I hope he will publish the evidence which appears to him to justify this conclusion, for the opinion of employers of labour in other parts of India is that the Bengali is, as a rule, deaf to all the inducements to emigration held out to him, because he is, on the whole, tolerably well satisfied with his lot. His wants are few and easily supplied; and when Mr. Caird contrasts his condition with that of the free black labourer in America, he forgets that Indian coolies have for ages, under native no less than under British rule, been accustomed to do a comparatively slight amount of daily labour for wages which they can live upon, but which would hardly keep body and soul together in any other country in the world. The indignation which is sometimes felt by Englishmen when they hear that in India the labourer is paid at the rate of 4d. to 6d. a day is quite misplaced. By religion and custom, all classes of Hindus are, as a rule, wonderfully abstemious; and the picture painted a hundred years ago of the Peishwa, or head of the Mahratta nation, sitting on horseback, with his spear stuck in the ground by his side, and making his dinner off a handful of parched grain, represents no extraordinary incident, but the usual way of life of all the Mahrattas, from prince to peasant. Possibly, even the English rural labourer, earning his 12s. to 8s. a week, but compelled to live on animal food and strong drink, and to buy plenty of warm clothing, and yet unable at all times to guard himself against cold and hunger, might envy the Indian coolie with his 4d. a day, who can be content with his meal of rice or grain, and with, perhaps, only a rag round his loins, is secured by his genial climate from knowing what is meant by the cold, which is the worst enemy of the poor in Northern Europe. One thing that usually escapes notice is the effect of the general employment of Indian women and children in out-door labour. This custom lowers the nominal rate of wages of the men, while, at the same time, it may treble or quadruple the earnings of each family.

The whole controversy about over-population resolves itself into this question:—Are the rates of wages relatively higher or lower in proportion to the prices of food-grains than they were ten or twenty years ago? It is unnecessary to go further back in our inquiry, because, if the process of exhaustion is really going on in India, it ought to be more plainly visible in its later than its

earlier stages. The elaborate report of the Famine Commission contains no exact information on the subject, and, while some of the Commissioners vehemently assert that the economical condition of the country is, on the whole, improving, others are bitterly dissatisfied with it. As the evidence taken by the Commission has not been published, we have no means of estimating the comparative value of these conclusions. I have thought, therefore, that it might be worth while to collect information on the subject from independent sources, and I have received from Mr. Middleton, a partner in the firm of Messrs. Glover and Co., the well-known railway contractors, and, I should think, the largest employers of labour in India, a valuable paper embodying the results of his many years' experience in the North-West and Central Provinces. He says:—

"NORTH-WEST PROVINCES.—I am of opinion that the wages of labour in general have increased to the extent of an average of 33 per cent.; some more, some less, but that the largest increase has been in the price of the common coolie labour. The reasons for this are various:— 1. Increase of work, consequent on the country being opened out by railways, &c. 2. Increase of acreage under cultivation. 3. Increase of various industries, such as cotton and wool mills, the tea industry, and similar highly cultivated productions opened out by Europeans. 4. The greater cost of food caused by the facilities of drawing away to the sea-ports for exportation of all surplus grain. Skilled labour has undoubtedly not made the strides that the ordinary working or coolie labour has made, and this I attribute to a larger number being trained every year as artisans—to my knowledge ryots have educated their sons as masons, carpenters, &c. I hold, that although population has slightly increased in the last decade, the average of grain food raised has in no way decreased. The country has passed through several years of under-average crops, but in the history of India and other countries such visitations have been not uncommon. They were far more severe in their results in ancient times, through the want of information and means of transit for food, but that the country is even now overburdened with population is what no one intimately acquainted with these provinces would assert. So far from such being the case (I speak from direct personal experience), it is now much more difficult to collect a large number of labourers on earthwork (which is the labour-key in this country) than formerly, at much enhanced rates, although they are also treated better. The working man is more independent; few are dependent for their daily food on the hand-to-mouth system, and I consider that the largely increased use of railways, as means of moving long distances, shows an accumulation of wealth which did not exist previously. Now, such accumulation could only have resulted from a smaller increase in the price of food than of wages, and the price of food is a sure indication of the too dense or meagre population of a district."

"CENTRAL PROVINCES.—Here there has been a large increase in the population, but not nearly in proportion to the increase of cultivation, and to the increase of returns per acre. Nowhere in India have the people bettered their position in the last ten years more than in this province. Grain is certainly somewhat dearer, through the facilities given by the Great Indian Peninsula Railway for exportation, but wages are quite 50 per cent. higher, through the agricultural population having benefited by increase of food-grains. Vast tracts yet remain to be brought under the plough, and these provinces could support several millions more than they do; but while district officers are doing their utmost to import labour from the (so called) teeming population of Bengal and the North-West Provinces, the fields sigh in vain for the rural population they hold out such rich attractions to. From the above considerations, I am of opinion that, apart from increased skilled cultivation, India can yet feed on its present production a population greater than now depends on it."

Mr. Glover himself writes:—

"In the North-West Provinces and Rajputana, where I have been engaged in making railways since 1872, labour has not only risen in value by about 50 per cent., but it has become scarce in proportion, this scarcity being, no doubt. caused by the increased demand for labour on the fresh land taken into cultivation, and by the gradual extension of railways. Wherever a railway is made, labour at once increases in price very much, and has never again receded to the price paid when a line was first started. In Bombay itself labour has certainly increased in price from 30 to 50 per cent. during the past ten years."

This statement with regard to Bombay is confirmed by my own experience of the rise in the wages of domestic servants, and labour of all kinds, in the Presidency town, at all events; and one cause assigned for the deterioration in the quality of the recruits for the Bombay army of late years is that the soldier's pay, once thought very liberal, is now less than the wages which can be earned by the same class of men in civil life. A gentleman, who has had great experience in letting contracts for large works in and near the city of Bombay, writes to me:—

"In 1868-69 the rates for coolies on the roads was from 3 to 4 annas a day, it is now 5 annas. Two to 3 annas was the charge for women coolies, now the charge is 4 annas. The rates for skilled labour in 1869, as compared with those now paid were, a good mason, 8 to 12 annas, now R.1 to R.1 4 annas a day; carpenters, 8 annas, now 12 annas to R.1."

In the rural districts of the Bombay Presidency, of course, the change has not been so marked. My friend, Mr. John Gordon, the secretary of the Bombay Chamber of Commerce, whose masterly papers on financial and economical questions are familiar to all persons interested in Indian affairs, has taken much trouble to supply me with tables, showing the variations in the prices of food and of skilled and unskilled labour throughout the different districts of the Bombay Presidency during the last ten years. These tables are printed on three following pages. I may say generally that they show very remarkable changes in the prices of food, while the rates for skilled labour have improved considerably in most districts, and those for unskilled labour have either remained stationary, or slightly increased. The food grains of Western India, jowari and bajri, are kinds of millet which are never exported, and which, therefore, are quite unaffected by the development of the trade with foreign countries. Their price varies with the more or less propitious character of the rainy season. Thus, in December, 1877 (a year of famine), only nine seers of jowari could be bought for a rupee in one of the rural collectorates, while, in December, 1880, 29 seers could be bought for the same money. The lot of the labourer, whose wages remain stationary, is, therefore, good or bad according to the abundance or scarcity of the seasons; and the evidence

STATEMENT OF THE PRICES OF FOOD GRAIN AT THE HEAD-QUARTER STATIONS IN THE BOMBAY PRESIDENCY.

Quantities per Rupee by Seer of 80 Tolas, or 16 Chitaks.

	Ahmedabad.		Kaira.		Panchmahal (Godra).		Surat.		Broash.		Khandeish (Dhulia).		Nassik.		Thana.		Kolaba.	
	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.
	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.
1877.																		
January......	18 8	14 6	16 13	13 15	21 4	16 0	11 10	11 7	13 14	13 5	16 0	14 12	16 1	12 11	13 9	10 9	...	...
February ...	19 0	14 0	16 0	13 10	20 0	15 4	11 13	11 10	15 4	13 5	15 11	13 12	15 14	12 11	11 5	10 9	...	...
March	15 0	13 8	16 0	13 10	20 0	14 8	12 12	12 1	16 0	13 5	17 3	14 5	15 6	12 11	11 1	10 9	...	...
April	15 2	13 1	16 0	13 15	18 10	14 8	12 3	12 9	13 4	12 13	15 14	14 4	15 6	12 11	10 14	10 9	...	...
May	14 7	12 1	12 13	11 14	14 14	13 0	12 0	11 7	12 13	11 4	14 12	13 8	13 4	11 8	10 10	10 9	...	...
June	14 7	11 0	12 6	11 7	12 11	11 10	11 3	11 10	12 5	10 10	13 14	12 12	12 9	11 5	10 0	10 5	...	...
July	12 8	10 12	11 7	11 6	13 5	12 1	9 4	9 7	10 8	10 7	12 10	11 7	10 8	9 10	8 3	8 6	...	...
August	8 8	7 12	7 14	6 7	10 10	9 5	7 14	8 4	8 0	8 0	9 2	8 12	9 1	7 6	7 11	7 10	...	...
September	7 4	7 12	7 2	7 4	9 5	7 10	8 14	7 13	7 10	8 13	8 13	8 9	9 9	7 9	7 1	7 10	...	...
October	9 0	8 8	9 3	8 4	8 14	7 4	9 11	9 4	9 2	8 11	10 10	9 10	13 4	9 2	7 1	7 10	...	...
November...	9 8	9 12	10 11	8 10	9 10	7 4	9 9	9 4	10 0	8 10	14 4	11 11	13 9	10 5	7 6	8 0	...	...
December...	10 8	9 8	10 0	9 0	9 4	7 4	11 3	9 4	10 11	8 14	14 6	11 11	15 4	10 7	7 14	8 5	...	...
1878.																		
January......	10 0	9 0	9 11	8 7	10 0	7 4	10 7	9 2	10 0	8 10	14 9½	11 12	13 10	9 14	8 8	8 5	...	...
February ...	10 0	9 0	9 4	8 10	9 6	...	9 12	8 3	9 6	8 3	12 8	11 0	11 13	9 2	8 8	8 5	...	...
March	10 0	8 8	9 11	8 10	8 6	7 4	10 4	8 7	9 11	8 0	12 0	10 11	11 3	9 0	8 8	8 5	...	...
April	10 4	9 4	10 0	8 14	8 6	7 4	10 15	8 11	10 8	9 2	12 7	11 5	12 6	9 11	8 8	8 5	...	...
May	10 8	9 8	10 0	8 14	8 14	8 0	10 12	8 7	10 5	9 6	13 6	12 1	11 0	10 6	8 2	7 15	...	...
June	10 4	10 0	10 0	9 2	8 10	7 9	8 3	9 14	10 0	8 14	13 6	12 7	12 0	10 2	8 2	7 15	...	...
July	11 4	10 8	9 13	9 13	8 7	7 9	10 7	8 11	10 10	10 7	14 9	13 10	12 2	11 9	8 4	8 1	..	...
August	11 4	10 5	10 5	9 10	8 14	7 9	10 1	8 11	9 6	9 7	15 14	15 2	14 0	12 12	8 15	8 11	...	...
September	8 12	9 2	8 1	8 5	9 7	7 9	9 6	8 4	9 8	9 2	14 6	12 9	12 0	11 2	8 15	8 13	...	...
October	8 12	9 0	8 14	8 1	10 0	7 9	9 4	8 7	10 0	9 6	15 4	12 7	12 0	9 15	8 15	8 12	...	...
November...	9 0	9 0	9 7	8 5	10 0	7 9	9 4	8 15	10 0	9 2	16 12	12 10	12 0	11 4	8 15	8 12	...	...
December...	11 0	9 8	9 7	8 10	10 0	7 9	9 4	9 4	10 0	9 4	14 9	11 12	6 0	11 4	8 15	8 12	...	...
1879.																		
January	11 8	10 0	10 11	9 0	10 0	7 9	9 4	8 11	10 0	9 4	13 12	12 6	...	11 4	8 8	8 5	...	...
February ...	11 0	9 8	10 5	9 4	10 0	7 8	9 6	9 6	10 0	9 6	13 13	11 14	...	11 7	8 8	8 5	...	8 0
March	12 0	10 0	10 11	9 8	10 0	8 0	9 4	9 11	10 11	10 0	13 14	11 14	...	11 8	8 10	8 10	...	8 0
April	13 0	9 0	10 5	8 14	10 0	8 0	8 11	9 9	9 11	10 0	13 14	12 7	...	10 11	9 1	9 12	...	...
May	13 0	9 8	10 11	8 14	10 0	...	9 8	9 13	9 11	9 13	11 4	11 7	...	9 12	9 2	9 3	...	...
June	9 0	9 0	10 0	8 14	8 14	8 14	9 9	10 8	9 8	9 6	11 4	11 0	...	9 9	9 2	9 3	...	...
July	9 0	9 2	...	8 10	8 14	8 0	9 4	10 8	9 8	9 6	11 11	10 7	...	9 14	9 2	9 5	...	...
August	9 0	10 0	...	8 14	8 14	8 0	9 2	10 4	9 11	9 6	13 5	12 13	...	9 14	9 1	9 3	...	...
September	8 4	10 8	...	9 7	8 14	7 12	9 0	10 2	9 3	9 6	10 6	10 1	12 0	9 12	9 5	9 11	...	...
October	8 10	13 8	...	13 2	12 7	9 8	9 3	10 2	9 0	10 11	10 10	10 15	12 0	9 10	9 5	9 7	...	...
November...	14 0	13 0	17 12	14 9	20 0	11 7	9 10	11 4	11 0	12 1	13 11	11 12	12 0	10 7	9 5	9 7	...	...
December ...	16 8	16 8	19 6	16 14	26 10	13 5	13 13	13 4	13 15	13 15	14 15	11 12	...	12 0	9 5	9 7	...	...
1880.																		
January.....	19 8	17 8	20 0	17 4	26 10	17 0	15 9	14 8	14 14	14 9	14 2	11 13	...	12 4	9 5	9 7	...	...
February ...	20 0	18 8	20 0	17 12	26 10	18 8	18 0	16 12	16 6	14 14	14 15	12 11	14 8	11 12	9 5	10 12	...	...
March	21 6	20 0	21 5	20 0	26 10	20 0	17 8	16 4	16 0	15 10	17 7	15 12	17 0	12 0	11 9	11 3	...	10 4
April	23 8	20 2	20 10	20 0	26 10	20 0	18 0	15 8	16 14	16 0	18 10	16 10	17 0	13 7	12 0	11 4	...	10 0
May	23 8	19 8	20 10	20 0	26 10	20 0	18 0	15 12	16 0	16 0	18 4	16 4	19 6	13 11	12 0	11 4	14 8	12 8
June	21 12	19 0	21 5	18 12	29 1	20 0	19 8	16 0	16 0	16 0	18 11	16 3	18 4	13 5	12 0	11 4	14 8	12 8
July	21 6	19 2	21 5	18 13	29 1	20 0	19 5	16 0	16 0	16 0	18 11	16 3	17 13	13 12	12 0	11 4	14 8	11 12
August	21 0	19 0	17 12	17 12	29 1	20 0	18 14	15 14	16 0	16 0	16 9	14 12	17 2	13 6	12 0	11 4	...	11 0
September	23 0	21 8	19 6	19 6	35 9	22 13	18 4	15 8	16 14	16 6	16 6	14 2	16 7	13 6	12 0	11 4	...	11 0
October	25 0	24 8	24 10	20 10	40 0	24 0	18 6	15 9	20 0	18 14	19 19	15 12	18 3	14 10	12 0	11 4	9 0	12 12
November...	24 8	23 4	26 5	20 15	42 13	24 0	21 8	17 8	20 10	17 12	23 10	17 15	23 1	16 10	12 0	13 14	12 12	17 4
December ...	29 0	26 0	30 8	24 10	50 0	24 0	23 2	17 8	21 5	17 12	26 5	20 4	25 5	17 10	12 0	16 5	13 12	18 0

STATEMENT OF THE PRICES OF FOOD GRAIN AT THE HEAD-QUARTER STATIONS IN THE BOMBAY PRESIDENCY.

Quantities per Rupee by Seer of 80 Tolas, or 16 Chitaks.

	Ahmednuger.		Belgaum.		Dharwar.		Kaladgi.		Kanara (Carwar).		Poona.		Rutnageri.		Satara.		Sholapore.	
	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.	Jowar.	Bayree.
1877.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.	s. ch.
January	13 4	12 12	10 4	10 7	9 3	10 0	7 15	...	12 0	10 8	11 6	11 8	11 4	11 11	10 10	10 6	9 14	11 7
February	12 0	11 11	10 0	10 8	10 3	10 14	8 3	...	12 0	11 0	11 15	11 8	11 4	11 11	11 12	10 6	9 11	10 9
March	11 13	11 11	10 0	10 8	10 2	10 8	7 6	...	11 8	11 0	11 15	11 8	11 4	11 11	10 10	10 0	9 15	11 4
April	11 12	11 11	9 0	9 13	8 11	9 6	6 2	...	10 8	...	10 14	10 6	10 5	10 11	9 0	9 3	8 10	9 13
May	11 0	10 12	8 0	8 2	8 1	8 12	5 6	...	9 8	...	9 13	9 12	9 1	9 2	8 5	8 6	8 13	9 3
June	10 8	10 7	6 14	7 6	6 12	7 0	4 12	...	9 0	...	9 13	9 12	8 12	9 2	8 5	8 6	8 3	8 4
July	8 9	8 11	5 1	5 8	4 13	4 14	4 1	...	7 0	...	7 1	7 3	...	7 2	5 11	5 13	6 11	7 2
August	6 2	6 10	4 9	4 14	5 4	5 5	3 14	...	7 8	...	6 2	6 7	10 10	5 13	5 15	6 2	5 3	5 12
September	6 6	6 12	7 5	7 0	6 7	6 2	5 5	...	9 8	...	8 7	7 10	8 12	5 13	8 0	8 6	6 14	7 13
October	9 2	8 14	9 6	8 14	7 11	7 4	6 3	...	14 4	...	9 4	9 3	10 0	5 13	10 10	11 10	8 0	13 8
November	11 0	10 10	15 12	15 0	12 0	13 12	7 10	...	16 8	...	10 14	9 3	10 0	5 13	10 10	11 0	8 6	13 5
December	11 12	12 2	16 2	14 13	17 8	17 8	8 13	2d. sort. 15 3	14 0	...	10 14	9 3	11 4	7 7	12 10	13 9	9 4	12 14
1878.																		
January	12 10	12 10	15 11	14 11	18 15	16 10	15 9	16 12	14 4	11 0	10 14	9 3	10 0	8 7	13 5	13 9	8 10	10 12
February	11 5	11 14	14 2	14 14	...	...	15 4	15 5	14 0	11 4	9 13	8 10	11 4	8 4	11 10	12 2	10 9	11 0
March	9 7	9 11	12 11	12 12	14 0	14 0	13 0	13 7	13 8	...	9 13	8 10	10 0	7 13	8 5	8 11	10 3	10 9
April	10 2	10 7	12 15	12 13	12 0	12 0	14 8	15 2	11 0	...	9 13	9 3	10 0	8 2	9 2	8 9	10 0	11 0
May	10 2	10 6	11 0	11 0	8 2	...	9 8	10 11	11 0	...	9 13	9 3	10 6	8 14	8 13	8 12	10 12	11 13
June	9 5	9 11	9 5	9 5	8 2	7 9	8 4	8 8	9 0	...	9 13	9 3	...	8 6	8 0	8 4	8 13	10 7
July	9 7	9 13	9 2	8 11	7 10	7 9	8 6	8 4	9 0	...	10 5	10 5	9 3	8 6	8 5	8 5	8 9	9 4
August	10 13	11 9	9 15	9 14	8 12	8 10	10 12	10 2	9 0	9 0	10 14	10 6	9 1	8 8	8 5	8 14	8 8	9 3
September	10 6	10 12	12 1	11 3	10 13	10 10	13 0	13 4	9 0	9 0	9 12	9 3	9 1	8 8	7 10	8 2	7 12	8 12
October	10 3	10 3	12 5	11 10	9 8	8 0	...	...	9 0	...	10 5	9 12	...	8 4	7 11	8 4	7 6	8 12
November	10 13	11 10	12 2	12 5	12 0	12 0	15 14	16 14	9 0	...	10 5	9 12	...	7 15	8 0	8 9	8 6	10 13
December	10 14	12 4	14 11	14 0	19 0	17 0	18 8	17 6	9 12	...	10 14	10 6	4 8	7 10	8 0	8 14	9 2	11 15
1879.																		
January	9 14	11 14	14 4	12 15	15 0	14 8	14 6	13 4	10 0	11 0	10 14	10 1	...	8 8	8 3	8 15	8 15	11 9
February	11 10	12 13	12 13	11 11	13 0	11 8	12 14	11 6	10 0	10 8	10 14	10 1	9 2	8 8	8 15	8 13	9 6	11 4
March	11 12	11 12	11 13	11 8	14 0	11 0	13 7	12 10	10 0	10 8	10 14	10 6	9 2	7 10	9 5	8 13	9 2	11 4
April	11 5	11 9	12 7	12 12	...	...	12 0	11 13	10 0	11 0	10 14	10 6	10 6	8 9	8 13	8 10	9 5	11 11
May	9 10	10 0	9 8	10 0	10 0	11 4	10 2	10 0	10 0	10 8	9 4	9 3	10 1	9 4	7 8	7 9	8 5	10 9
June	9 8	10 1	9 6	10 3	11 0	8 0	9 10	9 12	9 8	...	8 11	9 3	...	8 4	7 8	7 7	8 11	10 5
July	9 12	10 2	9 12	10 8	11 0	10 0	9 13	9 13	10 0	...	8 11	9 3	...	7 6	8 0	7 13	9 2	11 4
August	10 8	11 1	10 2	10 8	13 8	12 0	12 11	11 10	10 0	...	9 8	9 3	...	7 6	8 1	7 12	9 4	12 11
September	10 3	10 5	11 0	11 0	15 0	14 8	10 15	10 9	10 8	...	9 4	9 3	...	7 6	7 6	7 9	10 9	12 4
October	10 8	11 3	12 0	11 11	15 0	15 0	11 15	12 9	11 0	...	10 14	9 12	...	7 6	8 0	8 3	10 5	12 6
November	11 0	11 13	13 12	13 6	16 0	18 0	18 8	18 0	10 4	...	10 14	9 12	...	8 4	8 13	8 14	11 8	13 10
December	11 6	11 9	17 8	15 14	19 8	21 0	22 4	20 9	11 8	...	10 14	9 12	12 0	10 6	9 0	9 1	10 10	13 6
1880.																		
January	12 15	11 11	16 14	17 13	21 0	20 0	20 13	18 11	14 4	13 0	11 6	11 7	12 0	10 6	9 5	9 6	12 15	13 8
February	14 0	11 14	17 8	15 10	21 0	19 0	21 2	20 0	13 4	...	12 8	12 1	13 0	9 13	10 7	10 0	16 1	16 10
March	14 11	13 4	17 9	16 2	21 8	18 0	21 8	21 1	13 8	...	15 4	12 10	13 0	9 13	10 12	9 6	17 1	15 13
April	14 14	13 9	17 8	17 8	22 0	18 0	21 14	21 5	14 0	...	15 4	12 10	13 10	10 7	11 15	9 1	18 8	16 5
May	15 11	13 6	17 8	18 0	22 0	18 0	20 10	20 9	14 8	11 0	15 4	12 10	14 5	10 7	11 11	9 11	19 0	16 2
June	14 10	13 11	17 2	18 2	22 0	18 0	21 0	20 12	14 8	12 0	14 2	11 8	14 5	10 7	11 14	10 6	18 9	16 9
July	15 5	13 7	17 4	19 0	22 0	18 0	24 4	22 8	14 0	11 8	15 5	12 12	13 0	10 7	12 5	11 0	19 0	16 12
August	15 1	13 3	16 12	19 8	22 8	18 8	25 10	25 11	13 0	11 8	15 4	12 1	...	10 7	12 5	11 5	19 6	18 2
September	15 9	13 6	18 4	19 5	25 0	21 0	21 3	26 8	13 0	...	15 4	12 1	13 0	9 7	12 2	11 9	19 0	17 0
October	18 6	17 1	21 11	22 2	29 0	21 0	34 5	30 12	16 0	...	17 6	14 15	15 3	11 10	13 11	12 13	23 4	21 13
November	23 12	21 1	25 0	22 9	34 0	21 0	32 5	29 15	17 8	...	24 9	16 10	16 13	12 13	16 11	15 17	28 7	27 0
December	24 7	23 2	24 0	23 11	34 0	21 0	34 5	35 0	20 8	...	21 12	18 6	16 14	13 7	17 12	17 9	29 5	29 0

STATEMENT OF THE PRICES OF LABOUR PER DIEM IN THE DISTRICTS OF THE BOMBAY PRESIDENCY.

Labour.	1871-72.	1872-73.	1873-74.	1874-75.	1875-76.	1876-77.	1877-78.	1878-79.	1879-80.
	R. a. p.	R. a. p.	R. a. p.	R. a. p.	R. a. p.	R. a. p.	R. a. p.	R. a. p.	R. a. p.
Ahmedabad :—									
Skilled	10 0	10 0	12 0	12 0	12 0	12 0	12 0	12 0	10 6
Unskilled	3 0	3 0	3 3	4 0	3 3	3 3	3 3	3 3	3 6
Kaira :—									
Skilled	10 0	10 0	6 to 10a.	6 to 10a.	6 to 10a.	6 to 10a.	6 to 8a.	6 to 8a.	6 to 8a.
Unskilled	4 0	4 0	3 to 4a.	3 to 4a.	3 0	3 to 5a.	3 to 4a.	3 to 4a.	3 to 4a.
Panchmahab :—									
Skilled	10 0	9 4	9 4	7 0	8 0	7 1	6 10	7 3	7 0
Unskilled	3 0	2 8	2 8	2 9	2 9	2 6	2 5	2 4	2 2
Surat :—									
Skilled	8 0	7 0	10 0	8 0	8 0	10 0	8 8	8 0	8 0
Unskilled	6 0	4 0	5 0	4 0	4 0	5 0	4 0	4 0	4 0
Broash :—									
Skilled	12 0	12 0	10 4	10 3	9 2	10 0	8 0	8 0	10 0
Unskilled	4 0	4 0	4 0	4 0	3 10	4 0	3 3	3 0	4 0
Khandeish :—									
Skilled	13 9	13 6	10 8	10 4	10 4	10 4	8 0	8 0	8 0
Unskilled	3 8	4 0	3 9	3 7	3 7	3 7	3 0	3 3	3 1
Nazik :—									
Skilled	14 0	12 0	14 0	12 0	12 0	10 0	10 0	12 0	12 0
Unskilled	4 0	4 0	4 0	3 0	3 0	3 9	2 3	3 0	3 0
Thana :—									
Skilled	1 0 0	1 0 0	8a to R.1	8a. to R.1	8a. to R.1	8a. to R.1 8a.	8a. to R.1½	8a. to R.1½	8a. to R.1½
Unskilled	4 0	4 0	2 to 6a.	2 to 6a.	2 to 6a.	2 to 7a.	2 to 5a.	2 to 5a.	2 to 4a.
Koloba :—									
Skilled	10 0	10 0	8a. to R.2	8a. to R.2	8a. to R.2	8a. to R.2	8a. to R.2	8a. to R.1½	8a. to R.1
Unskilled	4 0	3 9	3 to 4a.	3 to 4a.	3 to 4a.	3 to 4a.	3 to 4a.	3 to 4a.	3 to 4a.
Ahmadnugar :—									
Skilled	12 0	12 0	up to R.1	up to 12a.	up to 12a.	9 4	9 0	8 6	8 0
Unskilled	3 0	3 6	4 0	up to 4a.	up to 4a.	up to 3a.	up to 3a.	2 6	3 0
Belgaum :—									
Skilled	9 0	10 0	10 0	10 0	12 0	8 0	8 0	8 0	8 0
Unskilled	3 6	4 0	4 0	3 0	4 0	3 0	3 0	3 0	3 0
Dharwar :—									
Skilled	10 0	12 0	12 0	8 0	11 0	10 0	8 0	10 0	10 8
Unskilled	4 0	4 0	4 0	4 0	4 0	2 6	3 0	3 6	3 0
Kaladgi :—									
Skilled	12 0	12 6	12 6	12 3	12a. to R.1	12 0	12 0	12 0	12 6
Unskilled	7 6	7 7	7 7	6 0	3 6	2 0	3 0	3 0	4 0
Kanara :—									
Skilled	12 0	14 0	8a. to R.1	8a. to R.1	8a. to R.1	8a. to R.1	8a. to R.1	8a. to R.1	8a. to R.1
Unskilled	4 6	3 4	3 to 6a.	3 to 6a.	3 0	2 to 6a.	2 to 6a.	2 to 6a.	2 to 6a.
Puna :—									
Skilled	1 0 0	1 0 0	1 0 0	10 0	10 0	8 0	8 0	8 0	8 0
Unskilled	5 0	4 0	4 0	3 0	3 0	2 0	3 0	3 0	3 0
Rutnagiri :—									
Skilled	8 0	8 0	9 0	8 6	8 3	9 0	8 9	9 0	9 4
Unskilled	3 0	3 0	6 3	3 6	3 6	4 0	3 6	3 6	3 10
Satara :—									
Skilled	1 2 0	1 2 0	4a. to R.1	up to R.1¾	up to R.1	up to R.1	up to R.1	6a. to R.1	4a. to R.1
Unskilled	3 9	3 9	1 to 4a.	up to 8a.	up to 4a.	up to 5a.	up to 4a.	1½ to 4a.	1 to 6a.
Sholapore :—									
Skilled	12 0	12 0	1 to R.1¼	4a. to R.1	4a. to R.1	4 to 12a.	4 to 12a.	4 to 12a.	4 to 14a.
Unskilled	4 0	4 0	2 to 5a.	up to 4a.	up to 4a.	1 to 3a.	1 to 3a.	1 to 4a.	1 to 4a.

of these figures, so far as it goes, proves that, even in districts remote from the centres of industry, the "individual man," whose interests Mr. Caird wishes us to care for, has not been injured by British rule.

Another conclusion, which seems inevitable from this necessarily imperfect survey of the state of India, is the supreme importance of public works in that country. The construction of railways is everywhere accompanied by a rise in the prices of agricultural produce, and high prices are a sign of prosperity when the wages of labour increase, as we find they do, in at least an equal ratio. It was not the want of food, but the difficulty of bringing it within reach of the people in the districts stricken with a dearth, that caused the grievous loss of life in recent famines; and the description given by the late Lord Lawrence twenty years ago of crops of grain rotting on the ground in the Punjab for want of the means of transport to markets bare of supplies is still applicable to many parts of India. For it is not much to boast of that in the course of

thirty years we have built a system of trunk lines extending over nearly 9,000 miles, in a country as large as all Europe, excluding Russia. The United States add nearly as many thousand miles to their railway system every year, while we creep along in India, maintaining an enormous and costly establishment to superintend the construction of two or three hundred miles a year. This unwise parsimony has been endorsed by the Public Works Committee of the House of Commons in 1879, which expressly limited the annual amount to be expended on railways and irrigation works in India to £2,500,000; and it has its supposed justification in the state of the Indian finances. We are often assured that taxation in India has reached its utmost limit, and that still the revenue is insufficient to cover the constantly-increasing expenditure. It is a sufficient answer to this statement to say, that the total debt of India on March 31, 1879, only amounted to £138,000,000, of which amount £33,000,000 represents capital invested in public works, so that the debt against which the Government holds no property does not exceed two years' revenue. Without wishing to anticipate the budget which will be brought forward next week at Calcutta, I may safely prophesy that the results of the present financial year will astound critics who refuse to believe in the elasticity of India's resources, and who imagine her ruin must have been completed by the unfortunate blunder made last year about the cost of the Afghan war. Nor can it be pretended that the revenue is raised by an oppressive system of taxation. The salt tax alone touches the poor; and although it is, in some respects, objectionable—as all taxes are—there is no other article of general consumption which is used in such small quantities as salt, so that the amonnt of duty paid by each consumer is infinitesimal. As to the richer classes, there is no country in which their position as regards the payment of taxes is more enviable than in India, where for many years they even, by persistent clamour, succeeded in getting themselves exempted from direct taxation in any form, while the indirect taxes they pay are quite trifling. This being the truth about Indian finance, I would put it to you that a largely increased annual expenditure upon public works, and especially upon railways, is called for in the interest of the country. The Government, which receives more than £20,000,000 a year from the land, to which it stands in the place of a landlord, is bound to lay out a considerable portion of this revenue in works designed to increase the productiveness of the soil, and to give cultivators improved means of access to good markets; and such judicious expenditure would be amply repaid by the consequent rise in the value and rent of land.

But in what way should these works be executed, by private enterprise, or by the direct agency of the State? Lord Dalhousie reconciled the two by inviting joint-stock companies to raise railway capital under a Government guarantee; and this plan has worked well, for the guaranteed lines are admirably built and economically managed, and, while they now pay the full 5 per cent. interest, the control exercised by the State in return for the guarantee prevents the companies from abusing their privileged position by charging excessive rates and fares. But some years ago, when railway traffic was not yet developed, and the State suffered a heavy annual loss from having to make good the deficiency of interest at the guaranteed lines, the Government of India resolved to have nothing more to say to private enterprise, but to make its own railways for the future. It hoped thus to effect a great saving of money; and, to make assurance doubly sure, it determined to change the Indian railway gauge, and construct a system of narrow gauge lines, which would at least be cheap, if they were not so good as the broad gauge lines. This experiment was begun in 1870, and we are now able to assert that it has completely failed. From Mr. Juland Danvers's last report, it appears that about 2,500 miles of State railways had been constructed up to the end of 1879, at a cost of £25,000,000, so that the average cost has been £10,000 a mile, a rate at which private companies could easily have built the lines on the broad gauge. The working of the State lines, again, compares unfavourably with that of the guaranteed lines, the expenses of management forming a much heavier per-centage on the gross receipts, so that the net earnings are only at the rate of about £1 3s. per cent. per annum. Nor is the real cost of these lines fully shown in Mr. Danvers's report. The Indian Goverment, when it determined to construct its own railways, allowed the companies' experienced engineers to leave India by the score, while it founded an engineering college of its own at Cooper's-hill to supply recruits, who go out with all the practical part of their business to learn. The heavy cost of maintaining this college, and the pensions of the engineers trained in it, ought to be added to the charges for State railways. The chief cause, however, of the excessive expenditure on these lines has been the unfortunate decision of the Government to introduce the narrow gauge into India. Surveys were made, and hundreds of miles laid down on this gauge in Northern India, before the military authorities were able to convince the Secretary of State that break of gauge would be a fatal defect on lines intended for use in time of war; and then all this work was suddenly abandoned, and the gauge of the Punjab Northern and Indus Valley lines made uniform with that of the broad gauge system of the rest of India. The only important trunk line which the champions of the narrow gauge have succeeded in keeping in their hands is the newly-opened Western Rajputana Railway, which completes the direct connexion between the seaport of Bombay and the cities of Delhi and Agra; and, with regard to this line, the Governor of Bombay said the other day, on opening it, that it was so inadequate for the traffic, that before many years were over it would have to be taken up and reconstructed on the broad gauge. You can conceive what a blunder has been made with this line, if you will suppose for a moment, that London had no railway connection with Manchester except by a roundabout railway through York, and that, on a direct line being projected, the State insisted on having it built with a much narrower gauge than that used on all the lines in either the north or south of England. Evidently, such a break of gauge would defeat the very purpose the line was intended to fulfil, that of making communication

between London and Manchester quicker and more convenient, and this is exactly what has been accomplished by the Government of India with regard to the line from Bombay to Delhi.

I have insisted on this case at some length, because it illustrates what I take to be the cardinal defects of our administration in India, namely, the grasping love of power which too often distinguishes high officials, their insensibility to public opinion, and their dislike of private enterprise. The members of the Government of India are usually high-minded, able, and personally disinterested men; but, quite unused to freedom of debate, they cannot bear contradiction, and may even, as in the instance I have cited, be betrayed into spending millions to gratify a crotchet, rather than give way to outside criticism. Hence, it is sometimes said with truth, that India is the most theory-ridden country in the world. With the exception of one or two eminent officials, everybody, Europeans and natives, in India, condemned the adoption of the narrow gauge for the Western Rajputana line. The communities most deeply interested sent up to Simla protest after protest, only to have them treated with disdainful silence; the Government of Bombay itself remonstrated as warmly as it dared, till at last it received orders from the Viceroy in Council to say no more on the subject; and so, without excuse, without attempt at justification, this great wrong was done to the political and commercial interests of the country. Then, with respect to the construction of railways generally, any impartial observer can see that it would be better for India if the execution of new lines were entrusted to a number of companies, who would go on with the work rapidly and uninterruptedly, than that it should be left to a Government which cannot but act capriciously, and, therefore, wastefully, since works begun and half carried out are often stopped on account of the outbreak of a war or a famine, or merely out of deference to the prejudices of some new minister. The present prices of Indian railway securities in the English market show that the rate of interest to be guaranteed to the companies need not now exceed that at which the State borrows money itself. But the Government of India has always been jealous of private enterprise, and this jealousy shows no signs of abatement. The enterprise of unofficial Englishmen, hampered as it has been, has done great things for India. There is hardly an article of Indian agricultural produce exported, the trade in which has not been created or developed by English enterprise, and this animated agency has also initiated the cotton and jute mills, and other industries that are now providing diversity of occupation for the labouring classes. Yet what is the reward of these English adventurers, who ought, if properly treated, to become the mainstay of the administration? India is the only part of the British Empire in which the English merchant, planter, professional man, or tradesman is absolutely shut out from having any share in the government of the country. He pays his taxes, and the Government kindly allows him to join a volunteer rifle corps; nay, the compliment is sometimes paid him of asking his advice on legislative measures which affect his interests, and which are afterwards passed into law in utter disregard of any adverse opinion he may have expressed; but the Indian bureaucracy will not suffer him to enjoy a particle of executive authority, and it compels him to abandon the idea of permanently settling in the country. Even in the partially self-governing municipalities which have been formed in the great cities, and in which unofficial Englishmen have tried to gratify their taste for the management of public business, the officials keep a firm grip on the reins of power. A prefect is set over the corporation, to keep it in leading-strings; and the mode of election of members is so contrived, that the Government can always find the means of suppressing the show of independence. Mr. Fawcett lately commended India to English capitalists, as a fair field for investment. If he wishes capital to flow freely into India, let him and others interested in that country —no matter to which political party they may belong—remove, first of all, the political disabilities which are so keenly resented by all Anglo-Indians outside the official circle. The present ideal of Indian administrators seems to be to reproduce what the great German historian of Rome has described as the political condition of an imperial province, in which there were no Romans but "civil servants, officers, and schoolmasters." I, for my part, believe that the English Government will never strike root in India until it has created, or rather allowed to grow up, a strong middle class leavened throughout by the English element. As a matter of policy, high posts in the administration should be reserved for others than Government servants. In each of the provincial Governments, as well as in the Council of the Governor-General, the control of the Department corresponding to the Board of Trade should be entrusted to men practically conversant with mercantile affairs; and such appointments as the Commissionerships of Customs, of important municipalities, and of Harbour Boards, should be regarded as the legitimate rewards of public spirit among non-officials. Nor can I see any reason why the Railway Department should always be superintended by royal rather than civil engineers. It is a curious circumstance that the agent of an Indian railway, who, in India itself, would never have been thought eligible for a place in the executive Government, was selected a few years ago to be the director-in-chief of all the railways in Egypt. The Egyptian constitution is clearly more liberal than that of the Indian Empire. I would finally ask, with reference to this branch of my subject, if a solution of the difficulties connected with the maintenance of a European army in India might not be found in the enlistment of men for special service in that country, with the condition that at the end of a certain term of years they should receive grants of land and settle with their families in India. A chain of military colonies might thus be formed, which would greatly strengthen our hold on the country.

The next best thing to the adoption of a more generous public works policy that could be done for India, would be the abandonment by England of her exclusive and selfish policy of refusing to join in any attempts to restore the international value of silver as a medium of exchange. How cruelly India suffers through the depreciation of silver will be apparent when you consider that on the public remittances alone to the Home Govern-

ment the loss to Indian taxpayers amounts to about £3,000,000 a year, and that the effect of a rise in value of the rupee to 1s. 10d. would be a saving sufficient to cover the occupation of Kandahar. But the depreciation of the rupee is also severely felt by private remitters, by the holders of Indian securities of all kinds, and by owners of property in India; and, while a low rate of exchange unquestionably exercises a stimulating influence on the Indian export trade, it has, on the other hand, the compensating disadvantage of lessening the purchasing power of India as a consumer of English goods. The monied interest of England seems to me very shortsighted in refusing to listen to the complaints of India on this score, and in complacently declaring that a gold currency is quite good enough for England, and that other nations must look after themselves. An able writer has recently argued, with much force, that the steady decline in prices which is still going on in England, and which especially affects landowners, is the result of the growing scarcity of gold, now that that metal has become the only measure of international value, and the time may come when this fall in the value of all kinds of property will seriously affect the purchasing power of England herself, and deprive her of that control of the money market of which she is now so proud. Perhaps, while she still can command as much gold as she wants, it might be prudent for her to give a thought to the interests not only of foreign countries, but of her own great eastern dependency, and to send a representative to the Conference which is to meet at Paris next month to consider the best means of readjusting the value of silver as compared with gold.

Time fails me to speak of the reductions that are possible in Indian expenditure, but I believe Mr. Caird is right in saying that the higher ranks of the Civil Service in India are too well paid, when it is taken into consideration how few of the old penalties of exile a residence in India now involves. It is in the home charges, however, that the amplest scope for economy will be found. The increase in garrison, and furlough, and absentee allowances of late years is quite startling; and in the military department, in particular, the chief effect of reforms in the organisation of the army seems to be a steady increase in the amount of the non-effective charges in England. Last year, the amount expended in England for the retired pay of officers of the Indian service, including colonels' allowances, was £1,205,874. In fact, Pall-mall and St. James's-street swarm with retired Indian officers, while the supply of officers on duty with native regiments in India is kept as short as to reduce many of them to a state of inefficiency. Then the cost of the India-office at Westminster has increased, is increasing, and ought to be diminished. It now amounts to the sum of £215,804, against £173,000 in 1865. As the real business of the Government is done in India, and only the work of supervision in England, the India-office ought to be by far the most cheaply worked of our departments of State, but it actually costs as much as the War-office. Its distinctive feature is, that it provides for a Council of Anglo-Indian experts, at an annual cost of £20,000, without counting the salaries of its staff of secretaries and clerks, to advise the Secretary of State chiefly on matters of finance. The late Mr. J. S. Mill applauded the constitution of this Council as the most successful of modern application of the science of representative government; but experience has shown that it is of very little use, except to provide additional pensions for eminent Anglo-Indians. The House of Commons has practically taken the control of the Indian finances into its own hands; and, after the confession made by the India-office, last year, that it had not the means of detecting or remedying the blunder made in India about the Afghan War estimates, one may well ask what the financial supervision of the Council of India is worth. Surely, it would be better for the country if the Secretary of State could no longer reward a partisan, or silence an adversary, by giving him a place in the Council of India, and if eminent Anglo-Indians, on retirement from service in the East, entered public life in this country, and gave the nation the benefit, in the House of Commons, of the matured advice and criticisms which they now whisper vainly in the obscure recesses of the India-office.

One administrative reform which would certainly have the effect of changing the character of our rule in India I have not yet referred to—I mean the proposal for the more extensive employment of natives in the higher ranks of the administration. The Government of India, in its comments on Mr. Caird's report, declares itself in favour of a change in this direction, and says:—

"We have before us, and have referred to the local governments for consideration, a scheme of recruitment whereby the total strength of Europeans in higher offices might ultimately be reduced to 571 for the whole Bengal Presidency."

I confess that I should look upon the accomplishment of this scheme with great uneasiness, and, indeed, with alarm. To maintain the existing bureaucratic system of government in India, merely substituting native for European agency, would, in my judgment, be a fatal mistake. There would be no economy in such a change, because, unless you paid the natives as liberally as the Europeans, they would be dissatisfied, and the administration would consequently become inefficient and corrupt. Again, European civilians in India have even now too large a body of native subordinates interposed between them and the population. This is one great cause of the want of knowledge of and sympathy with popular feeling, which is often made a matter of reproach against them. Reduce their numbers still further, in order to increase those of native officials, and the English portion of the administration will be left completely in the air. All the machinery of government will be managed by natives, and in troublous times the English raj might be overthrown by official conspirators before the mass of the people knew what was intended. Of course, this may be the consummation desired by those persons who contend that we ought always to be preparing to leave India and to give back the country to the natives. But, though I have known many Englishmen who would talk about educating the natives of India for independence, I have never met one who would fix any date at which this transfer should be accomplished, or who was not ready to vote for spending the last drop of English

blood and the last shilling of English money to prevent such a catastrophe from happening in his day. This talk about India's future independence is, therefore, only the counterfeit coin of a false sensibility. I confess that I do not believe India can ever attain independence. Her people dread leaving their own country and crossing the ocean, and her coasts and foreign trade have, therefore, always been, and must continue to be, at the mercy of whichever power has the command of the seas; and the national character is so unwarlike that, even if Hindus and Mussulmans forbore fighting with one another, they could not hope, without European protection, to resist the inroads of stronger races from the north. England may then, with a good conscience, continue to hold India, if she takes care to act fairly and justly towards the people of that country, and tries to level them up to the enjoyment of constitutional liberties by proceeding cautiously in the path of decentralisation, and steadily enlarging the limits of municipal, and ultimately provincial, self-government, while at the same time maintaining the distinctively English character of the administration, and cherishing to the utmost, instead of endeavouring to efface, the English element of the population. By such a policy we should, I am persuaded, do more good to a country, in whose future I take the deepest interest, than by making it over to the tyranny of a native bureaucracy; and, by persevering with it, we might hand down to our successors our imperial inheritance undiminished in strength and lustre, hoping that from them in turn it would descend to following generations with "better title, better opinion, better confirmation." It should, indeed, be the most ardent aspiration of every true Englishman that, for the sake of both countries, the connection between England and India may never be dissolved; that it may never be said of our native land, in the mournful language of Wordsworth's epitaph on Venice,—

> "*Once* did she hold the gorgeous East in fee,
> And *was* the safeguard of the West;"

but that, for ages to come, England may still retain these proud titles to the admiration and the gratitude of the civilised world.

DISCUSSION.

Mr. Peterson said he had listened with very great interest to the paper, and generally speaking, he agreed with the remarks made in it, but time would not allow him to comment as he would desire upon some of the suggestions it contained. Neither directly nor indirectly would he run a-muck against the authorities who held the government of India. As India had to be governed by us, we must make the best of it, and maintain our rule in the country at all hazards, and at any cost. If England were to desert India to-morrow, and the country were left to itself, more terrible scenes of bloodshed than the world had ever seen would ensue, and India must become the prey of some northern nation, whether Russia or China. Our Cassandras at home were altogether too fond of running down the connection of England with India, but he could testify to the improvement in the country during his own connection with it, as a sailor and as a barrister, since 1829; and if the prophets of evil were better acquainted with the actual facts, they would spare many of their utterances. Famine must ever be a visitant of any country parched under the tropical sun, and dependent for its necessary moisture on irrigation works, but in that respect it could not be gainsaid that Government had done its best during many past decades. As a large employer of labour in India, he might say that in former years he had hundreds of coolies at work for six pice a day, and the rate of increase in wages was shown by the fact that, when he left India, they could not be got at ten pice a day; and as to the value of grain in some districts, seventy-two seers, or 144lbs., were then sold for a rupee, while at Patna, a rupee would purchase only thirty-five seers. That was not the case now. It could not be said that the condition of India had deteriorated under English rule. There were many points in connection with that rule upon which he could have dilated, for he had never been a particular supporter of the Government, but he would say that, as far as in them lay, though they might have done more, they had ruled India better than any other country had ever governed a dependency. On the question of the grain supply, people who said the country was going to the dogs had to reconcile with their statements the astounding facts that the wages of agricultural labour had very greatly risen, and that unless more grain had been produced the people could not have existed in the country. Trade and commerce were necessities of humanity, and although from our original position of traders we had been compelled to become conquerors in India, we must support our future rule by extending her commerce. Damage had not been done by our supremacy to the condition of any classes of the people, certainly not to the working classes; and the general amelioration throughout the country showed what we had done, let our own Cassandras or continental critics say what they might. Our efforts would be quite as much for our own benefit as for that of India. Anglo-Saxon energy was necessary for her, and the Aryan spirit was simply again flowing southwards to arouse the torpor of the Asiatic. Asiatics could never of themselves have started railways, and the introduction of them had, in fact, been opposed by the Brahmins, as one of the consequences following in their wake would be the destruction of caste. The paper was far too extensive in its scope to be fully discussed now, but after its publication in the *Journal* there would be opportunities of commenting upon the topics introduced in it. A population of some 34,000,000 in the time of Warren Hastings had, at the period when Sir George Campbell was in office, increased, it was estimated, to 65,000,000. Such an advance in the numbers of a people was the best test of increased food supplies, and also that the people were better fed. From his connexion with the Bengal Coal Company, which was a very large employer of labour, he could speak personally of the improved condition of the working population. People, also, who had any interest in the tea-cultivation knew how much the price of labour had increased. He could, personally, give no information with regard to the North-Western Provinces, but what he had said about the improved condition of the labouring classes, certainly applied to Eastern Bengal. If decay was was going on in India, she was the most extraordinary specimen of the process conceivable, in view of her increasing population, higher rates of wages, and larger exports. Excessive taxation was another reproach levelled at the Government; but he did not believe that, at the present moment, they extracted as large a revenue over the whole country as was wrested from it by the Emperors Akbar and Aurungzebe.

Sir James Elphinstone, Bart., said his acquaintance with India commenced sixty-one years ago, and at that time there was a good deal said about the acquisition of the Deccan, and about our territories being very circumscribed. He had since then made repeated visits, and had been struck with the extraordinary change in the condition of the native population. He travelled through

the southern parts of India in 1842 and 1846, and on returning there in 1870, was astonished at the great increase in the prosperity of the country. From his experience while in the House of Commons, where he served on most of the Indian Inquiry Commissions, until last year, he was acquainted with the remarkable increase in the rate of wages of the working population, and he had obtained from the Commissariat Department a list of prices, during 20 years, of the articles required for the subsistence of the army. Those returns showed that the increase had actually been from 30 to 60 per cent. in the bazaar prices during that period, and they were to be found in the appendix to the report of the East Indian Committee, before which he had laid them. His own experience, therefore, thoroughly bore out that portion of the paper.

Sir Joseph Fayrer, K.C.S.I., F.R.S., regretted that the subject generally was one upon which he was ill-qualified to speak, but he would venture to say a few words on the improved sanitary condition of the country, which was a matter more within his knowledge. Certainly in that respect there had been a most material improvement during the last half century, as was shown by the fact that the death-rate had been reduced from 50 or 60 per 1,000 fifty years ago, to about 15 or 16 per 1,000, by the operations of the Government. Though he was not prepared at the moment to give figures, he believed also that the duration of life among the native population had greatly increased. He could quite confirm what had been said about the improvement throughout the country in other respects. On the question of colonisation referred to in the paper, though he expressed any opinion with great misgiving, and could not very well give exact data for his belief, his own conviction was that the Anglo-Saxon race would never colonise the continent of India. He had, it was true, seen instances of second and even third generations of Anglo-Indians, born and matured in the country, but they always bore about them significant indications of decay. His own belief was that European colonists could never have any permanent existence in the plains and valleys of India, though how far they might be acclimatized in the upper and hilly regions he would not say. That was one of the questions for consideration in the future of India.

Colonel Malleson, C.S.I., agreed with almost every word in the paper, but must make a qualification on behalf of himself and other retired Indian officers, as he rather demurred to the reference made to unfortunate gentlemen who had nothing to do but to walk up and down Pall Mall. He hoped, by long service in India, they had deserved some provision on retirement, and that having returned at last to England, they were still able and ready to render further service to their country.

Mr. Russel Aitken, on the subject of public works in India, also agreed with most that had been said in the paper. As Mr. Maclean had pointed out, the break of gauge had not only been a great misfortune but was quite uncalled for, as indeed had been the 5 ft. 6 in. gauge originally fixed. The Indian Government began upon the railways in a bad way. Instead of adopting the gauge found efficient in other countries, they appointed a Commission of experts to consider the matter, and everybody knew that whenever that was done the experts were sure to go wrong. Experts' opinions were very valuable in guiding practical men; but among themselves they would be led by the most opiniated, who was generally the most wrong-headed of them all. That was the case in India when the railways were being planned; and three engineers having been appointed as a committee, decided that the 5 ft. 6 in. gauge gave the best results, and that was selected in preference to the 4 ft. 8½ in. gauge, but the 5 ft. 6 in. gauge has been found, after a long trial in other parts of the world also, to be too wide. Then General Strachey adopted the mètre gauge. A railway was wanted up the Indus Valley, and the Governor-General in Council determined that that gauge should be adopted. At Simla, in 1869, he (Mr. Aitken) was asked his opinion upon the matter by a member of Council, and he replied that he thought it was a mistake, but that it was more a military matter than an engineering one. He was informed that Lord Napier was very much against it, but, in spite of this, the result was that the Public Works Department carried their point, and the railway was commenced on that narrow gauge, and had to be altered. And so it was with all the public works. The harbour at Kurrachee was originally designed by an engineer of great experience in harbour construction, but a military engineer, who had ideas of his own, thought proper to stop the works, and so they remained for six years, when the original plans were allowed to be carried out, and the works were found to be eminently successful. Harbour works at Madras, too, which had been attempted to be stopped, but they had lately turned out to be a great success. The fault was not so much that these matters were left in the hands of one set of men or another, military engineers or civil engineers, for men were very much alike, and there were good and bad in all professions; but, in public works, publicity was wanted, and before any works were undertaken, or, at all events, before any money was spent on them, a public inquiry should be opened. At present, these matters were all managed by resolutions in Council, founded on papers, which, if read by the members of Council, he felt pretty sure, would often not be understood by them. Open inquiry, such as was made by the House of Commons upon public works, was what was needed, and that would ensure common sense being brought to bear upon the construction of such works in India. It would be very desirable also to give companies more scope for private enterprise, unfettered by the Government; it was of no use trying to put them in leading strings, as had occurred in the case of the Madras Irrigation Canal Company. The Government should content itself with offering guarantees of so much money per mile on railways, and leave the companies to sink or swim by their own exertions, getting no money if they failed, but if they succeeded, then, so much the better for them. He certainly agreed, therefore, with most of the opinions expressed in the paper, radical as they were on several points.

Mr. Juland Danvers demurred to some of the remarks as to official obstruction contained in the paper, coming, as he did, from the particular hive where the bees were described as receiving too large a share of the honey for unnecessary work. Some of the points touched upon should be adverted to, lest the meeting might be under misapprehension with regard to the desire of the Government upon the question of executing public works through private enterprise in India. Mr. Maclean spoke favourably of the guarantee system, and it had undoubtedly been the means of producing beneficial results to the country. It had simply been adopted for want of a better, and without any idea originally of the control on the part of the Government, which became necessary as soon as they became interested in the returns of the railways. Twenty-five years ago the first attempt was made to assist a joint-stock company in this country to raise money for works in India, but it failed. Efforts were then made in other directions to induce English capitalists to provide money for the construction of Indian railways, but it was found that nothing short of an absolute guarantee would suffice. Within a comparatively short period, under the guarantee system, upwards of £100,000,000 had been expended upon railway works; but at any time the Government would have rejoiced to find that public works required in India would be carried out

entirely by private enterprise. Capital is much wanted in India, and for the erection of cotton and jute mills, and for the opening of coal mines and other industries it has been forthcoming. Many such undertakings were being conducted without any help from the Government, and they might hope that better times were coming in regard to works of public utility, so that before long the artificial and objectionable security of the Government guarantee would not be necessary, in order to attract capital to India. Obstacles would never be placed in the way by Government. Surprise could hardly be felt at some of Mr. Maclean's remarks on the management of the Public Works Department in India, but some excuse could be offered in its behalf in the circumstances in which it was placed. It had been in an experimental stage, and was in a transition state. Such conditions always involved expense, trouble, and difficulty, but it was to be hoped that was now past, and that the success of the existing railways would lead to the introduction of purely private enterprise, which would neither be opposed nor hampered, but heartily welcomed by the Indian Government.

Mr. A. Rogers thought the remarks in the paper on decentralisation suggested the germs of most extensive reforms in the Indian administration; and he sincerely hoped that the attention of statesmen, both in India and England, would be directed to the subject. Until a few years ago, the financial administration was entirely carried on in Calcutta, but the central administration had been considerably relaxed, and more power entrusted to the local Governments in financial matters. People who knew India would admit that that had produced a beneficial effect; and it would hardly be denied that local affairs could be managed better in the provinces than by the central Government at Calcutta, at a great distance. He hoped to see the system still more extended in administrative as well as financial matters, as he believed the people had great powers for self-government. Education was spreading among them, and they were becoming more and more fitted to manage their local affairs.

Mr. J. T. Wood desired to say a few words on the subject of the mètre-gauge railway and guarantee systems. There appeared to be now traffic more than enough on the Indian lines to fully develop the capacities of the metre-gauge, and the time had perhaps come for an alteration of that gauge in some instances. That work would not be very difficult; it had been done on several occasions in America by proper organisation of labour and application of materials, and it had been shown that a great number of miles of railway could be altered in a few hours in that respect. He would venture to say that 100 miles of railway could be altered without stopping the traffic for more than a few days, and in saying so, he would be far within the mark. As to the guarantee system, there was no material difference between that and the actual construction of the railways by Government, because they were making railways with the money borrowed at the ordinary market-rate in England, and they would not be paying less *cæteris paribus* by guarantee, because the rate of interest in England had fallen within the last few years from five to four per cent., at which the Indian Government could borrow any money they required. People might say what they liked, but the difficulty in making railways by private enterprise was that the public had more confidence in the superintendence and check of the Government over such works, than they would have in the promoters of them. Directors of companies might be men of the highest honour and probity, but still people in this country had lost so much money by railway enterprises, that they considered the Government guarantee a check upon even their own selected officers. It had been said that people might make railways anywhere in India if they chose to find the capital for the purpose, but the Acts regulating the construction of railways had to be complied with, and they constituted a material Government check on private enterprise. He could not, under those circumstances, see that, so far as the investing public in England were concerned, there was much difference between the giving of guarantees and the construction of railways by the Government itself with money borrowed in this country. Upon the subject of exchanges, he was afraid that any mere alteration of currency would not have the effect of making a material difference in the value of the rupee. To take from commerce one article of barter would be ineffectual; what was wanted was a universal currency for Great Britain and her colonies and dependencies. That should be no impossibility, however unattainable the greater desideratum of a universal currency for the whole civilised world might be, for Australia had already joined in the scheme, and a measure of value as extensive as possible, not confined to a single country like India, should be adopted. Whether the adoption of a universal currency would alter the value of silver, was a totally different matter, and he had never been able to understand why these two questions were not considered separately. Another subject which had hardly been alluded so, was the recent working of gold mines in India; and one point of great public interest in conconnection with it, was the relative rights of property in the Government, and in private individuals, in the gold fields. If their possession by the latter was the exception, he failed to see how the working of them could have any great effect on the future rates of exchange; and if the property in them belonged principally to the Government, that would be another step in advance towards obtaining a universal currency for Great Britain and her colonies.

The Chairman, in proposing a vote of thanks to Mr. Maclean, thought the meeting would bear out his (the Chairman's) introductory remark, that they might expect to hear from that gentleman an address which would be both interesting and eloquent. Of course, as the representative, to some extent, of the official classes, he could scarcely endorse the paper in its entirety, though he thoroughly concurred in its general tenor. It would have been desirable, had time permitted, that the official side of the disputed points should have been fully stated. However, it was very satisfactory to have heard from non-official gentlemen so much in confirmation of the improved state of the country; and that, after all, afforded the best proof of the official ability with which the affairs of India had been conducted. Though not an engineer, he could not refrain from adding his own testimony to the great devotion and professional ability which engineers engaged on public works in India, whether in the service of the Crown or as, in technical phrase, civil engineers, had displayed; and whatever faults might be found with the constitution of the Public Works Department, or with the manner in which those works had been carried out, the public works of India constituted a grand record written by England on the face of the land, and a worthy monument of British energy and scientific skill. Cooper's-hill College, he might say, was now being placed on a broader and more liberal basis, and it would probably receive engineers who would serve their country at home, as well as those destined for service in India. That institution would supply a great desideratum for India, namely, technical education. He asked to be excused at that late hour from going further into many of the interesting questions which had been touched upon in a way to throw new light upon matters of the greatest interest to natives and Anglo-Indians.

Mr. Maclean, in returning thanks, fully recognised the impossibility of doing justice to so vast a subject within the limits of a short paper, and could not do better than refer the meeting for further information

to Sir Richard Temple's own valuable work, published since his return from India. With regard to the observations upon public works, and the encouragement of private enterprise in carrying them out, he believed that they were done more cheaply in that way than when executed by the State. Government-constructed railways were much more costly, both in execution and management, than the guaranteed lines, but at the same time, State control was very useful in preventing monopolies and overcharge to the public. He had feared some portions of the paper might be distasteful to Sir Richard Temple, but he had full confidence that their Chairman would welcome criticism upon questions of such great importance, and he would conclude his remarks by proposing that the meeting should join in thanking him for having kindly presided.

The vote of thanks was cordially passed, and the meeting terminated.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 9th, 1881; Lord Alfred S. Churchill in the chair.

The following candidates were proposed for election as members of the Society:—

Appleby, Francis James, The Rowans, Lee-road, Lee, S.E.
Bayley, Sir Edward Clive, K.C.S.I., C.I.E., Ascot.
Brass, John H., Wentworth-house, Manresa-road, Chelsea, S.W.
Brothers, William, Meadow-head-house, Livesey, Blackburn.
Cahen, Albert, 7, Bayswater-hill, W.
Godfrey, William Bernard, 54, Regent's-park-road, N.W.
Jenkinson, Edward George, 26, Palace-gardens-terrace, Kensington, W.
Ogg, Surgeon-Major G. S. W., 8, Belsize-avenue, Hampstead, N.W.
Staight, Daniel George, 63, Tulse-hill, S.W.
Roper, Richard, 143, Lewisham High-road, New-cross, S.E.
White, Frederick Anthony, Kinross-house, Cromwell-road, S.W., and 85, Gracechurch-street, E.C.

The following candidates were balloted for, and duly elected members of the Society:—

Brevetor, Thomas, Kimberley-house, 2, Evering-road, Stoke Newington, N.
Harris, Edward, London, Upper Canada.
Smith Henry, J.P., Ellingham-hall, Bungay.
Underdown, Robert George, A.I.C.E., Manchester, Sheffield, and Lincolnshire Railway Company, Manchester.
Uren, John C., Cornwall-terrace, Penzance.

The paper read was—

ASCENT OF CHIMBORAZO AND COTOPAXI.

By Edward Whymper.

I have been invited by the Society of Arts to deliver a lecture to you upon a journey which I recently made to the great Andes of the Equator. Some of you may perhaps think it strange that anything connected with mountain travel or mountaineering should be brought before you; but if you consider for a moment, you will at once perceive that the art of mountaineering is a high art, and is therefore worthy of being encouraged by the Society. Up to this time, most of the loftiest portions of the earth are totally unexplored, and this arises principally from the fact that the mountaineer, in addition to experiencing most of the troubles which are met with by other travellers, has to deal with some which are peculiar to his work. I do not now refer to the distressing hæmorrhages, alarming vomitings, and painful excoriations which are said to afflict him. Hæmorrhages and excoriations are rather alarming words, so long as they remain untranslated into ordinary language; but they do not seem to be so very formidable if they are called bleeding at the nose, and loss of skin through sunburn; and it may also somewhat tend to allay alarm, if I say that I have never known cases of bleeding at the nose occur in mountain travel, except to those who are subject to the complaint; while, with regard to vomiting, it has only been known to occur to persons who had taken something to disagree with them. But there is another trouble, which cannot be dismissed so lightly. All travellers, without exception, who have ever attained great altitudes, have spoken of having been affected by another complaint, and this complaint is known to affect even natives of those regions, and persons who have lived in them, as well as casual travellers. This is usually called mountain sickness. There have been numerous conjectures put forward as to its cause; very often it has been supposed to be the work of mysterious spirits, sometimes it has been attributed to weakness, and other causes, but there can be very little doubt that it arises simply from the diminution of atmospheric pressure as one goes upward. At 20,000 feet the pressure is less than half the amount that it is at the level of the sea, that is to say, whereas at the level of the sea the atmospheric pressure is generally capable of sustaining a column of mercury of 30 inches, at 20,000 feet it will not sustain a column of 15 inches. Now, those of you who have witnessed experiments with the air-pump, must know that remarkable effects can be produced by reducing the pressure of air. I well remember the first occasion on which, when at school, I saw an old and shrivelled apple placed beneath the air receiver, and I watched with glee its wrinkles disappear gradually under a diminished pressure, and the apple fill out again, until at length it became as plump as it was in the days of its youth. The effect I then witnessed struck me as so remarkable, that I at once determined to see if I could not recommend its further application, and on my return, home, I suggested that the appearance of my grandfather would be greatly improved if he could be put under the air-pump; but as this application of science to my progenitor caused an application of something else to me, I have ever since regarded myself, in a small way, as a martyr to science. From seeing air-pump experiments, and other purely philosophic considerations, it is obvious that the human system must be liable to derangement, if subjected to sudden diminution of the atmospheric pressure to which it has been accustomed. These depressions have often been so severe as to render mountain travellers incapable, and their lives well nigh unendurable, so it is scarcely to be wondered at that they have endeavoured to escape from the infliction, by descending into lower regions. I do not know of a single instance of a traveller, who

having been afflicted in this way, has deliberately, so to speak, sat it out, and had a pitched battle with the enemy. Nor am I aware that anyone has ever suggested the bare possibility of coming out victorious from such an encounter. Yet upon doing so depended the chance of pushing explorations into the highest regions of the earth, and I long felt a keen desire to know whether my own organisation at least could not accommodate itself to the altered conditions. From considerations which would occupy too long to enter into now, I gradually acquired the conviction that patience and perseverance were the principal requisites for success, and the journey of which I am now going to speak was undertaken with the view of bringing this matter, amongst other things, to a definite issue. In the course of it we camped out at very great heights, twenty-one nights were spent above 14,000 ft. above the level of the sea; eight more above 15,000 ft.; thirteen more above 16,000 ft.; six more above 17,000 ft.; and one more at 19,000 ft. I shall not now anticipate what you will presently hear, but I have made these preliminary observations to render less frequent interruptions of the narrative, and for the purpose of explaining allusions in it which might otherwise perhaps have been only half understood.

Fifteen years ago, when my apprenticeship to the art of mountaineering was finished, and I cast my eye over the map of the world in search of new districts, it was not long before it was directed to the great Andes round about the Equator, they being, perhaps, the mountains of the most exalted reputation, and of great elevation, which still were little known. The highest of the group, Chimborazo, long accounted to be the loftiest mountain in the world, had received the attention of travellers of great celebrity, and in recent years its ascent had been essayed by French, Germans, Americans, and Ecuadorians. All had failed, and each succeeding failure increased the desire I felt to annex it to my own country. To-night I shall speak to you of Chimborazo and Cotopaxi alone, and I select these two mountains on account of the contrast which they afford. The one is capped by eternal snow, and the other burns with perpetual fire. Chimborazo is an extinct volcano, while Cotopaxi is an active one, and is, I believe, the loftiest volcano in working order.

I left Southampton for this journey on November 3rd, 1879, and arrived at Guayaquil on the 9th of the following month. At the time of my arrival, this town was affected considerably by the war between Peru and Chili, and its inhabitants evinced the most impartial desire for the success of both sides. It has been described by previous travellers as a place where there is always something doing, either there is a revolution going on, or an earthquake, or a fire, and this description is fairly accurate; and when I tell you that assassinations were occuring in the streets every day, you will perceive that it is a place well suited to a person of adventurous temperament. Besides this, it may be mentioned that the rivers round about swarm with alligators, and the surrounding land with snakes, many of the most deadly kind. I was not in the town during the wet season, but I am informed that at that time the river overflows the exterior land, and that the non-amphibious vermin in general climb posts and trees, and exhibit the most extraordinary spectacle. You see snakes hanging by the tail from rails, sitting on the top of posts, struggling and writhing in all kinds of inconceivable ways to escape from the deluge; while associated with them are scorpions and all kinds of strange creatures for which science has scarcely a name.

From Guayaquil, we went by a river steamer to Bodegas, and at that place our journey may be said to commence. My party consisted of two Italian mountaineers (cousins), Jean Antoine and Louis Carrel; a Mr. Perrin, whom I had picked up at Guayaquil, to interpret; and a number of mules and muleteers. The road we followed was the grand route to Quito, and almost all the trade from the coast to the interior passes over it. Its difficulties have been much exaggerated. It is a track, or series of tracks—generally very narrow, often very muddy; and there is a constant passage of mules, well laden with the most varied goods. Sometimes "Perrier Jouet" champagne is found assorted with iron bedsteads; then one sees sheets of corrugated iron laid flat across the backs of donkeys, or a grand piano carried on the heads of six or eight Indians. In the reverse direction, you have droves of beasts, often 20 to 30 in a group, coming to the coast, bringing huge bales of quinine bark, accompanied by gangs of shambling Indians, who, for the most part, are very civil. The labourers generally have a good day or a good night for the traveller; but, in respect of the language they employ to their beasts, I can only say that, in comparison, the observations of an angry London cabman are decent, and those of a drunken bargeman are moral.

Three days' travel from Bodegas brought us to the town of Guaranda, and here I found a portion of my heavy baggage, which had been sent out some months in advance. This town is 15 miles in a straight line from Chimborazo, which was the central point of the journey. Many of you were probably under the impression that Chimborazo is often seen from the Pacific. There is an eloquent passage in Prescott's "Conquest of Peru," describing the magnificent prospect which it affords to the mariner. The fact, however, is that it is very seldom seen from the ocean. Captains who go up and down the coast say that they do not see it more than three or four times in 13 or 14 years. And, when I tell you that it is distant 91 miles in a direct line from Guayaquil, and from that place is elevated less than 2° above the horizon, you can form your own idea as to its magnificence from the Pacific Ocean, which is 66 miles still farther away. Up to this time we had not seen Chimborazo at all. We started from Guaranda on December 19th, still continuing the Quito road, and passed over the southern slopes of the mountain to see if we could commence to make out a route which should promise a chance of success. We came right on the mountain before we saw any part of it, and from that day the summit was always enveloped in clouds. It was obvious we could only go as far as we could see; so we returned to Guaranda to wait until the summit was clear. Whilst returning, I was overcome with dizziness, feverishness, and intense headache, and had to be supported by two of my people for the greater part of the way. Imagining I was attacked by fever, I took 30 grains of sul-

phate of quinine in the course of the night, and was covered up with mountains of blankets, but next morning there was nothing the matter. As the symptoms were those which occurred at a later period, when we were undoubtedly leaving the low atmospheric pressure, I ultimately concluded that it was through this that my indisposition was caused. On this point, allow me to say a few words further with regard to the troubles which occur to persons who get to great altitudes. Although the heights of the Andes, which we were about to visit, had not been well determined, there was reason to believe that several of them approached, if they did not exceed, 20,000 feet. At the time of our departure there were only three tolerably well authenticated instances of persons having reached that height on land, and I could learn nothing which was of the least service respecting the experience of those who were engaged in those expeditions. But from others who had reached altitudes of from 17,000 to 18,000 feet, I heard a confirmation of my supposition that, at such great elevations, I ought not to expect a continuance of the immunity from mountain sickness which I had hitherto enjoyed. I made up my mind, therefore, before we left, that, sooner or later, we should suffer like the rest of the world; but, being of opinion, as I have already said, that patience would overcome mountain sickness, it was my intention, on all our expeditions, first to establish camps as high as we could force the natives and mules; and, as it would be impossible to retain the natives at those positions, it became necessary to provide ourselves with food sufficient for weeks, or even for months, so that, in the event of our failing in our enterprise, from badness of weather, mountain sickness, and other causes, we should not have the mortification of being obliged to abandon our positions simply from want of sustenance. And as it could not be expected that we should be able to obtain on the spot the provisions which would keep for such a length of time, I concluded that the only safe course was to make ourselves, from the first, entirely independent of the resources of the country, in the matter of the food which should be consumed at the greatest heights. About two tons weight of the most portable and most condensed provisions went out for our use, and, irrespective of the things which were bought already tinned, more than 2,000 tins were soldered down. If time would permit, it would be interesting to enter into details respecting our outfit, but I must do no more than say that our provisions were arranged in boxes weighing 75 lbs. a piece. Two of them made a mule-load, and each of them held three tin cases, soldered down, each of those three tin cases containing food for four days for one man. They included everything necessary except water and fire. The preparation of these provisions and the rest of the outfit occupied almost as much time as the performance of the journey, and it appears to me desirable to say this much on the subject, lest any persons who should be tempted to follow in our track should be inclined to doubt our veracity, through finding it impossible to progress with reasonable rapidity. A great saving of time was effected by arranging the food in this manner, and if a small journey was made, which was calculated to occupy two men for four days, I had only to say take ten cases, instead of continually calculating, and then being afraid that candles, salt, or matches might be forgotten.

After two days more, we saw the upper part of Chimborazo for the first time; it appeared to be fine, and so I sent off two guides to select a camping place on the ridge we had examined on the 19th, whilst I completed the preparations for the journey. They returned on the 23rd, very much fatigued, having found a place which was suitable at a height, so it appeared afterwards, of 16,500 feet above the sea. Then Christmas came in the way, and our start was delayed until the 26th, when we at length got off—a caravan of nineteen persons and fourteen mules. Shortly before our departure from the town, I had the honour to receive a visit from the political authorities, and I did not at first perceive what was the object of the interview; but just before they left, the principal official thus addressed me:—"Señor, we understand perfectly that, in an affair like yours, it is necessary to dissemble a little, and you, doubtless, do perfectly right to say that you intend to ascend Chimborazo, a thing which everybody knows is impossible. We know perfectly well what is your object; you wish to discover treasure which is buried in Chimborazo, and, no doubt, there is much treasure buried there, and we hope you will discover it; but we also hope that when you have discovered it you will not forget us." "Gentlemen," I said, "I should be delighted to remember you, but in respect of the other matter, the treasure, I venture to suggest that you should pay half the expense of the expedition, and take half the treasure we discover." But this idea was rather too speculative for them, and the interview produced no result.

On our way up, we went over the Quito track, and then, leaving the road on our right, we bore away directly towards the mountain. Night set in just as we were fairly arrived at its foot, and we encamped at a height of 14,400 feet, having risen 5,500 feet in coming from Guaranda. During the night two Indians, who had been acting as porters, deserted, and five mules also ran away. Our carrying power being thus reduced, it was necessary to make two journeys from the first camping place on the ridge, to a place very near the summit, S.W. by S., where the Carrels had selected a place for the second camp. Jean Antoine went away with the first detachment, and Louis and myself returned to fetch up the others. The rest of us then went up and arrived at about a quarter to five in the afternoon, having risen about 2,100 feet. We were now more than 16,500 feet high, and established ourselves there with provisions enough for three weeks, and with fuel enough for several days. All water had to be obtained by melting snow, of which there was enough round about us, and to keep up our stock of fuel and communications with the world below, I retained a muleteer and one beast to go backwards and forwards between our camp and the nearest hovel.

All the rest of our troop now left us, and did so very gladly; for although we had succeeded in establishing our camp on the selected spot, it had only been done by the greatest exertions on the part of my people and their beasts. The mules were forced up the very last yard that they could

go, and staggering under their burdens, which were scarcely more than half the weight they were accustomed to carry, stopped repeatedly, and by their tremblings and falling on their knees, and general behaviour, showed that they had been driven to the very verge of exhaustion. When we arrived at the second camp, we ourselves were in good condition, which was to be expected, as we had ridden up the entire distance from Guaranda; but within an hour I found myself lying on my back, along with both the Carrels, placed *hors de combat*, and incapable of making the least exertion. We knew that our enemy was upon us at last, and that we were experiencing our first attack of mountain sickness. We were feverish, had intense headaches, and were unable to satisfy our desire for air, except by breathing with open mouths. This naturally parched the throat, and produced a craving for drink, which we were unable to satisfy, partly from the difficulty of obtaining it, and partly from the difficulty of swallowing it, for when we got enough, we were unable to drink, we could only sip; and not to save our lives could we have taken a quarter of a pint at a draught. Before one-tenth of it was down, we were obliged to stop for breath, and gasp again, until our throats were as dry as ever. Besides having our normal rate of breathing largely accelerated, we found it impossible to get along without every now and then giving a spasmodic gulp, just like fishes when taken out of the water. Of course there was no desire to eat; but we wished to smoke; and even our pipes almost refused to burn, for they, like ourselves, wanted more oxygen. This condition of affairs lasted all night and all the next day, and I then managed to pluck up spirit enough to get out the chlorate of potash, which, by the advice of Dr. Marcet, I had brought in case of need. Chlorate of potash was, I believe, first used in mountain travel by Dr. Henderson, in the Cara range, and it was subsequently ordered by Sir Douglas Forsyth in his mission to Yarkand in 1873-4. The surgeon to the expedition states that he distributed little bottles of it amongst the members of the embassy, and says that, from his own experience, he can testify to its value in mitigating the distressing symptoms produced by a continued deprivation of the natural quantity of oxygen in the atmosphere. Before my departure, Dr. Marcet urged me to experiment, with a view to confirming this experience; ten grains to a wine glass of water was the dose recommended, to be repeated every two or three hours if necessary. I say distinctly that I thought it was of use, though it must be admitted it was not easy to determine, as one might have recovered just as well without taking any at all. Anyhow, after taking it, the intensity of the symptoms diminished; there were fewer gaspings, and in time a feeling of relief. I am so far in favour of its use, that I should always carry it on future expeditions. Louis Carrel also submitted himself to the experiment, and seemed to derive benefit, but Jean Antoine, the elder of the two, sturdily refused to take any doctor's stuff, which he regards as an insult to intelligence. For all human ills, for every complaint, from dysentery to want of air, there was, in his opinion, but one remedy, and that was wine; most efficacious always if taken hot, more especially if a little spice and sugar were added to it. His opinions on things in general were often very original, and I learned much whilst in his company; amongst other things, that for the cure of headache, nothing better can be mentioned than keeping the head warm and the feet cold. I am bound to say he practised what he preached, and I can remember no more curious sight than that of this middle-aged man, lying nearly obscured under a pile of ponchos, with his head bound up in a wonderful arrangement of handkerchiefs, vainly attempting to smoke a short pipe, whilst gasping like an asphyxiated codfish, his naked feet sticking out from underneath the blankets, when the temperature in the tent was much below the freezing point.

It seems curious to relate that Mr. Perrin did not appear to suffer at all, and except for him we should have fared somewhat badly. He kept the fire going—no easy task, for the fire appeared to suffer from want of oxygen just like ourselves, and it required such incessant blowing, that I shall consider for the future a pair of bellows an indispensable part of a mountaineer's equipment. Mr. Perrin behaved on Chimborazo in an exemplary manner—he melted the snow, brought us drink, and attended to our wants in general; it goes, therefore, somewhat against the grain to say that he was in very poor health in consequence of having led rather a dissipated life, in fact, he was so far debilitated that he could not walk a quarter of a mile on a flat road without desiring to sit down, or 100 yards on a mountain side without being obliged to rest. Had I been aware of his previous history, he certainly should not have accompanied us. You will naturally inquire—How can you account for this man, with his shattered constitution, who also was no mountaineer, being unaffected, when three others, who were all more or less accustomed to high ascents, were, for a time, completely incapable? The explanation appears to be this. Perrin had been for a long time resident in Ecuador, at heights of from 9,000 to 10,000 feet, and had several times passed backwards and forwards over a height of over 14,000 feet. The mean elevation at which he had resided during the last 10 years was, in all probability, much higher than the mean elevation at which we others had lived, and it would probably have been found, had he been subjected to examination, that his manner of respiration, and even his organs, had become better adapted to a pressure of $18\frac{1}{2}$ inches, which was the height of the mercurial column at our second camp.

On December 29th, the Carrels were somewhat better, and were eager to be off exploring, so I sent them away to continue the ascent of the ridge on which our camp was placed. I instructed them not to go to any great height, and to look out for another and higher camping place. The rock of our ridge was trap—I have a sample of it here—it was shattered by frost, and everywhere in a state of ruin. Just above our tent, it was easy enough to traverse a stony waste, mingled with patches of sand. Higher up it became precipitous, and, at about 17,000 feet, it was necessary to climb a little. Then its angle diminished, and there were large snow drifts on each side; still higher, the crest of the ridge was composed of gravel, and frozen ice. At 18,500 feet the ridge came to

an end. It was crossed by some precipitous rocks, and after passing these, you entered on the snow region which crowns the mountain on all sides. On the east of this ridge we had rather a considerable glacier, which was fed, if not entirely formed, by the ice which fell from above, and at its sides there were sheer cliffs, over which the glacier which caps the mountain was projected. The slices of glacier which fell from these cliffs tumbled over the precipices and the slopes at their base 3,000 feet before they were arrested by the glacier beneath, and in the course of falling brought away enormous fragments. The glacier was laden with smashed ice blocks and the rocky fragments which it brought down, and we accordingly called it the *glacier de debris*. These cliffs, and those which face W.N.W., are the most elevated and the greatest of Chimborazo, and they were quite sheer and inaccessible. They were composed of a number of well marked strata, disposed with great regularity, and it was easy to identify the beds from which fragments had fallen on the glacier by the colour alone. All were trap; some were vitreous; others stony, and they presented the widest variety of colours, from a delicate rose to a coarse red, and from pale grey to the black of the beds of scoriæ. The whole of the rocks, and I collected some 30 varieties, are distinctly volcanic, and the doubts which still seem to linger on this matter are now finally disposed of. The very highest rock I obtained, from about 15,500 feet, is an absolute cinder.

The Carrels returned soon after dusk, both extremely exhausted; they could scarcely keep on their legs, and threw themselves down and went to sleep without eating or drinking. Their condition, and the report I heard next day, rendered it certain that our second camp, as a starting place, was not placed high enough. It appeared that the Carrels, neglecting their instructions, had been towards the summit, and reached a height of only about 19,500 feet. They were quite unencumbered, carrying no instruments, and only enough food for their own use, and had no traveller to look after, and yet came back quite exhausted. It was obvious, therefore, we should have to get still higher up before we could make an exploration of the real summit. So soon as they were well enough, I sent Louis down to the camp to fetch up the tent, which had been left there, and as soon as it arrived, we were in a position to go forward again. On the following morning, I went myself up the ridge to look for a higher camping place, and found one on the eastern side on some broken rocks, at a height of 17,400 feet. By this time, I was in rather better condition than the Carrels; the feverishness had disappeared, and my blood had resumed its normal temperature. The gaspings had nearly ceased, and the headache had gone. You will perhaps wonder how I knew I was feverish; for in regard to this matter one is often mistaken, and fever is supposed when it does not exist. By the advice of the distinguished physician whose name has been already mentioned, Dr. Marcet, I had provided myself with a registering clinical thermometer, for the purpose of taking the blood temperature at great elevations. This was duly done, and, in respect of this matter, nothing more need be said than that at our greatest heights the temperature of the blood was just as it is at the level of the sea—higher during periods of warmth, and lower when unusually cold. But still, at its normal height, when the thermometer is at 60° or thereabouts, it did not appear to be affected by a low atmospheric pressure at all. In recommending me to take this little instrument, of which I have one in my hand, Dr. Marcet rendered me a great service, and amongst all the devices and instruments which have been pressed upon the attention of travellers in general, of late years, I know nothing equal to it in importance. By constant observation, I was able to detect the earliest advances of fever, and by taking proper steps in time, was able to get through the entire journey without having an attack of fever worth mentioning. Its expense is trifling, and it can easily be carried in the waistcoat pocket. When we were first laid on our backs by mountain sickness, it showed that my blood temperature amounted to 100·4°, but by the end of the year it had fallen to its usual height, viz., 98°. Still, although the more disagreeable symptoms had gone, we found ourselves remaining comparatively lifeless and feeble, with a strong disposition to sit down when we ought to have been moving. There was plenty just about this time to keep us moving. First the muleteer, who was retained to keep up communication, came up and reported that some boxes left in depôt at the first camp had been broken open and robbed. This involved going down to make an inspection, and dispatching Perrin to Guaranda. Then we found a quantity of tinned-meat had gone bad, and we had a world of trouble over it. I had invested in a quantity of ox-cheek, and one tin had been placed in each of our cases. Upon opening the first case, I noticed that the end of the ox-cheek tin had bulged, and, knowing what that meant, I had it thrown away at once. One after another we found the same thing, and at once, on opening another, a most vile stench rushed out, and I found the ox-cheek had burst its bonds, and not only became putrid itself, but had corroded and ruined almost the whole of the food in the case. It then became necessary to examine seriatim each case, to know exactly how we were off for food, and the end of the matter was, we found ourselves obliged to hurl over the cliffs, provisions that had cost us, in round numbers, £100.

It would be merely wasting your time to recount the troubles we had in the wind, hail, snow, and thunderstorms—which we had night and day—from which we suffered each and all. The snow fell occasionally as much as six inches at a time; it was always fine and granular, and not in flakes. But we had far more hail than snow, and it fell continuously. Thunderstorms visited us with unvarying regularity every day. These occurrences delayed our progress, and it took three days to move the requisite quantity of material up to the third camp. At length, on the 2nd January, last year, having passed the night at our highest station, leaving communication open in our rear, I conceived the time had arrived when we might prudently make for the summit, and on the following morning, at half-past five, the Carrels and I started, and mounted about 1,000 feet without any great difficulty. We had arrived at the rocks I have spoken of as crossing the ridge of the mountain. We were half way up this when a furious and intensely cold wind arose, and we found our-

selves compelled to abandon all the things we were carrying, and to fly for refuge to the camp, holding ourselves in readiness to start the next morning. This happened to be very fine and cloudless, and profiting by the steps we had made the previous day, we mounted by a fair road, crossing these rocks and getting to a height of about 18,400 feet at eight o'clock. We then bore away to the left, that is to say, towards the west, over a snow-covered glacier, and ascended spirally, so as to break the ascent. There were few crevasses; the snow was in good order, although steps had to be cut in it. I noticed that our steps got shorter and shorter, until at last the toe of one foot touched the heel of the previous one. At 10 a.m., at a height of 19,500 feet, we passed the highest rock, which, I have already said, was nothing but a volcanic cinder. For some distance further we continued our progress at a reasonable rate, having fine weather and a good deal of sunshine. At about 11 a.m., we fancied we saw through the heavy clouds which covered the whole country to the west, and shortly afterwards, being then nearly 20,000 feet high, we arrived at another plateau near the top of the mountain. The summits now seemed within our grasp; we could see both, one on our right, and another a little further away on our left, with a hollow plateau about one-third of a mile across between them. We remarked that in about another hour we could get to the top of either, and not knowing which of the two was the higher, we made for the nearer, but at this point the condition of affairs completely changed, the sky became clouded all over, wind arose, and we entered a large tract of dusty, soft snow, which could not be traversed in the ordinary way. The leading man was up to his neck, almost out of sight, and had to be pulled out by those behind. Imagining we had got into a labyrinth of crevasses, we turned about right and left to try and extricate ourselves; and after discovering it was everywhere alike, we found the only possible way to proceed was to flog every yard of it down, and then crawl over it on all fours, and even then, one or another was frequently submerged, and almost disappeared. Needless to say, the time went rapidly. When we had been at this sort of work three hours, without having accomplished half the remaining distance. I halted the men, pointed out the gravity of the situation, and asked them whether they preferred to turn or go on. After consulting together, Jean Antoine said, "When you tell us to turn we will go back; until then we will go on." I said, "Go on," although by no means feeling sure it would not have been best to say "Go back." In another hour and a half, we got to the foot of the southern summit, and as the angle steepened, the snow became firmer again. We arrived at the top of it about a quarter to four in the afternoon, and then had the mortification of finding it was the lower of the two. There was no help for it, we had to descend to the plateau, resume flogging the road, and floundering on, to make for the highest point. There again, when we got up to the dome, the snow was reasonably firm, and we arrived upon it at last, standing upright like men, instead of grovelling, as we had been during the last five hours, like beasts of the field. The wind was blowing at the rate of about 50 miles an hour from the north-east. We were getting wretched and hungry, without having the means to satisfy ourselves. With great trouble, a mercurial barometer was set up, one man grasped the tripod, another attempted to give it shelter by a poncho from the wind, and I, myself, lay on my stomach in the snow watching the descent of the mercury. It fell until it was 14·1, at a temperature of 14° Fahr., which, when compared with an observation made on the same day at Guayaquil, gives for the height of Chimborazo 20,540 feet. By the time the barometer was in its case again, it was 20 minutes past 5 o'clock, and there was scarcely an hour and a quarter of daylight remaining. We fled across the plateau at the highest possible rate. There is, as you are aware, a great difference between descending and ascending soft snow, and as we had a huge trough or groove already made, we moved down it with comparative facility. Still, it took nearly an hour to extricate ourselves from that plateau; we then ran, for our lives, for our arrival at the camp that night depended on our being able to cross those rocks before darkness fairly set in. We just succeeded in arriving at them in time, although it became pitch dark before we crossed them; then we saw our camp fire, and heard the disconsolate shouts of Perrin, who was left behind, as we came hurrying down, and we arrived there soon after 9 p.m., having been out nearly 16 hours, on foot the whole time.

The hurried way in which we left the summit, made me desirous of ascending again, but I found that Louis Carrel was *hors de combat*, from having his foot frost-bitten. As soon as it could be done, he was sent down to the nearest place where he could receive attention, and I remained myself up two days longer at the second camp. On the 12th of January I rejoined them, and we then moved by easy stages down to the Machachi. We waited there for nearly four weeks before he could take the field again. The poor man suffered very severely, but it is due to you to say that it was through his own fault. On leaving the tent for the ascent, I remarked he was not wearing gaiters, but he said he was accustomed to go without. Jean Antoine used gaiters of the usual type, and I used a pair which, from having the leather continued all round, are well nigh impervious to water. In wading through the snow of the summit it was wet as well as soft, and Louis Carrel got his feet badly wetted, and afterwards they froze, whereas Jean Antoine and I returned to the camp quite untouched.

My residence on Chimborazo thus extended over 17 days; one night was passed at a height of 13,400 feet, ten at a height of 16,500 feet, six at 17,300 feet. During this time, besides the ascent to the summit, I also went three times as high as 18,300. When we quitted the mountain, all trace of mountain sickness had disappeared, nor did it touch us again until we arrived at the summit of Cotopaxi.

This is a convenient point, before passing on to Cotopaxi, to say a few words respecting the country and the people of the country, their manners and customs. The road to Quito, I have already said, goes over the southern side of Chimborazo. It then passes around the eastern side of Chimborazo, and then goes further down to Arenal, and so to Quito. As far as

the house, called Chuguipoquio, is for the most part only a rough mountain track, but here again you come to a made road, which continues without intermission to Quito. This is the only made road in the whole interior, and it is a busy one, with plenty of life passing along it. In December, 1879, I reckon we met or passed not less than 1,300 beasts, and 500 persons every day. A newly-arrived European is somewhat astonished, that with this large traffic, the track should be left in such a villainous condition, but after having been over the other so-called roads in the interior, his surprise disappears, and he begins to regard the Quito track as something very superior indeed. I am bound to say I did not on any part of it see mud more than two feet deep, whereas in other roads we had mud three and four feet deep. Even this is considered a very small amount, and an old resident in Ecuador once rebuked me for calling a road bad in which our beasts had sunk half way up their flanks. On asking him what he called a bad road, he said:—"A road is bad in which the beasts tumble into mud holes and vanish quite out of sight." On the Quito road you meet with a great diversity of character. A large portion of the population, probably one half, is composed of pure Indians, who were found by the first Spanish conquerors. The remainder of the population consists of people of a mixed race. It is universally admitted that their are very many Indians of perfectly pure descent, whose families have never been tainted by alliance with whites, but it does not appear to be possible to find a single Spanish or other European family which has not contracted alliances with the Indians. We had many dealings with the Indians, and found them on the whole to be honest, truthful, and well-disposed. They are certainly, for the most part, hardy, industrious, and tolerably intelligent. They are also sober. We saw extremely little drunkenness amongst them, except in the Province to the north of Quito, where they are very numerous and prosperous. The small number of intoxicated persons seen throughout Ecuador is remarkable, and I was inclined to regard the whites as a very sober race, until I learned that it was the habit of the country when any one wished to get drunk, to go to bed and get quietly drunk in bed. This is a very interesting custom, and it might be advantageous to introduce it amongst ourselves, until drunkenness is abolished altogether. The greater part of the persons mentioned on the road, are naturally those concerned in the traffic between Guayaquil and Quito and other towns in the interior. Travelling for the sake of seeing the country is of course unknown; but occasionally you meet with some one a little out of the common, who is travelling to pay a visit to some neighbouring farm; and such a person is generally worthy of inspection. If he is got up correctly, he will be wearing his so-called Panama hat, a straw hat which will roll up, and costs any sum from about 10s. to £10. To take care of this precious article, he puts on a white outer casing, and as this would get spoilt by the rain, he puts an oil-skin cover on the top of that, so that he has three hats on, one over the other. To protect his eyes, he ought to be wearing a pair of blue goggles, which are sold in Birmingham at half-a-crown a dozen, and, in Quito, at half-a-crown a-piece. Outside he will probably have on a poncho of superior quality such as this, and underneath it a coarser one. What he may wear in the guise of trousers I cannot say, because they are covered with buskins made of the skin of some wild animal. His feet are very nearly invisible, and if you see them, you will most likely notice his toes peeping through his shoes, but, for the deficiency thereabouts, he makes up in the heel by his spurs. Here is a specimen of these articles, but this is considered a moderate thing in spurs; I can assure you many are worn more than double the size, Altogether he is what we should call a regular guy. But we have not yet done with him. If he is properly turned out, he carries at his button-hole a drinking cup, which may be carved and silver mounted; at his side a tremendous chopping knife, which is used either for cutting away branches or as a tooth-pick. If he is a person of great distinction, he will be strong in his whip, which will have a wrought-iron handle, as it is found that one of that description does not break so readily on the heads of mules as wooden ones. He will also carry a guitar at his saddle. Such a person, according to the phrase of the country, is a great cavalier, and if only decently mounted, he may aspire to marry any woman in the land. It is needless to say that, in roads in the state I have described, there are many accidents to baggage animals; beasts get stuck, their loads are thrown off, and sometimes abandoned, but what causes, I believe, far more loss, is the pilfering which takes place, and which it is almost impossible to prevent. I have been offered bottles of brandy by persons on the road, who, I am quite certain, could not have come honestly by them, and I have seen wine cases taken off a mule, taken indoors, opened, a bottle or so taken out, the case fastened up again, and loaded. To illustrate this I may tell you a case which was related to me on a visit to a fraternity of Jesuits. One of them said to me, "Señor, you know that the wine of this country is both dear and bad, and we thought that if we imported it ourselves, direct from France, we might get a pure wine at a moderate price; and so we ordered, as an experiment, a cask from a French house, but it cost us very dear. When it arrived, we were glad to find that it was full, and that it did not leak; but I am sorry—oh, I am sorry to tell you, that when we opened it, we found that it was full of very dirty water." These accidents, and the weight of the heavy duties which are imposed are, no doubt, the main cause of the high price of foreign goods at Quito, and in the interior generally. An ordinary quart bottle of "Bass" costs 4s., and a pound of English salt, 3s. 4d., while a common iron bedstead, that would be dear in London at 50s., I have seen marked at £9. Accidents notwithstanding, these prices appear to leave a good margin for profit, and an enterprising man could probably make 100 per cent. on his transactions. You must remember, however, to take into account an unknown quantity of earthquakes and revolutions. You may be a rich man one day, and a bankrupt the next. Trade in these regions may be said to possess all the excitement of gambling without its immorality; but it does not appear to be very fascinating to the English, for,

at the time of my visit, I found only two of my countrymen in Quito. In touching on morals, I tread on delicate ground, because what the Ecuadorians consider moral, we should term immoral. I shall, however, relate one instance, which conveys a vivid idea of the manners and customs of the country. Some years ago, the late Archbishop of Quito, who was a much respected man, moved to indignation by the immorality of some of his flock, tendered a reproof; but some sons of Belial, in revenge, stole into the vestry on the occasion of an important church festival, and put strychnine into the sacramental wine. The Archbishop partook of it, and fell dead before his people. This incident created so great a sensation, that the authorities forgot to punish the assassins, who are still at large, and—perhaps, to prevent a repetition of such things in future—they suppressed the Archbishopric, and seized a great part of the revenue. You have here developed in this single instance a gross, immoral, and atrocious crime which is left unpunished, and a flagrant disregard of vested rights. As this is the description of the people themselves throughout Ecuador, you will see good reason for the non-interference of a strangers in their politics. I studiously avoided meddling with their concerns; still it was not possible to be any length of time in the country without hearing a good deal about its domestic affairs, and in some respects these are both interesting and edifying. The Parliament, or House of Assembly, it is said, comes together only on rare occasions, and when it meets it manages to do without all-night sittings, and its members obey the ruling of their President, and vote exactly as they are wanted. It might be worth while for her Majesty's Government for the time being to send a special commissioner to Ecuador, to learn how this desirable state of affairs can be arrived at. Then with respect to finances, they manage extremely well. There is no augmentation of the public debt, for the simple reason that no foreign country will lend them money, and the inhabitants are far too wise to lend it to each other. This universal distrust arises from the undeviating habit of repudiating contracts. No bargain ever seems terminated, and in respect of this matter, one of the most respectable and honourable of foreigners in Quito told me that he never considered a transaction completed until he had given his customer a whipping. The marks of the whip, it seems, answer the place of a receipt stamp. The Ecuadorians are, as I have said, a very interesting people, and there is much that is curious and amusing in their manners and customs, but it is most pleasant to study these at a distance.

In passing from Chimborazo to Cotopaxi, we go from an extinct volcano to an active one, and to one of the most terrible volcanoes in the world. It is situated, roughly, north-east from Chimborazo, at a distance of 65 miles. From Quito, it bears south-east about 33 miles. Three years ago, during the last great eruption, ashes from it fell in Quito to such an extent, that it was pitch dark at mid-day, and persons in the streets in front of their houses could not tell where they where. On this occasion, too, there was a great manifestation of flames, which rose to an enormous height; the larva rapidly liquified, and poured down in vast torrents, which caused rivers six miles distant to rise 60 feet above their ordinary height, and in one instance, I was informed, it carried away a bridge 100 feet above the stream in the village of Antisana, where a cotton factory was established some 25 miles from the mountain; the whole place was razed, and the heavy machinery was carried 30 miles down the river. All round the mountain the natives have stories of the tremendous ravages which occasionally occur. The general opinion seems to be, that the periods of greatest activity are always preceded by periods of repose. In fact, it is said of the mountain, as it is of children, when it is quiet it is sure to be in mischief. During my enforced stay, through illness last March, I was in the immediate neighbourhood of this mountain, and had abundant opportunities of studying its behaviour. It was unusually tranquil, and although fretting and fuming, and giving occasional growls, conducted itself on the whole in a quiet, well-behaved manner. I several times remarked that during the night much less smoke or vapour came away from the crater than during the day, and this led me to conclude that if we could pass a night on the summit, we should be able to see to the bottom of the crater, a sight no one had hitherto enjoyed. So far as one could judge by examination with the telescope, it did not appear that we should be able to find a reasonably protected place on the all but naked final cone; so, in addition to the troubles which were likely to occur from living at a great altitude, we had the chance of being blown up by the mountain, or being blown away by the wind.

All our arrangements were carefully matured, and we started for Pichincha, passing at first through a small hamlet, then turning south, and then up a ridge of the mountain, which descends towards the west, and encamped at a height of about 15,000 ft. As the transport of our camp equipage, all through, was beyond the power of the Carrels, I called for volunteers from amongst the natives, and those who came we now proceeded to dress up in accordance with our own views of propriety. The native dress is as unsuited to mountaineering as it can well be; commencing with a straw hat, which always blows away; then a long poncho, a variety of blanket, with a slit in the middle, through which the head is passed, and this is sure to fly up in your face at a critical moment; then rough shoes, which, although not unsuited to ordinary use, are totally inadequate to snow or rock-work. The rest of their attire is of the most flimsy description. I am speaking now, of course, of the inhabitants of the interior, living at a height of 8,000 or 10,000 feet, at which there is an almost invariable temperature of 50 or 60 degrees. In the lower country much less dress is worn, and they seem to have attained, in some cases, the perfection of simplicity. I hold in my hand the entire dress of a native of St. Miguel-del-Colorado. This is a fit dress either for a garden party or an evening assembly, and as there appears to be some connection between unscantiness of attire and perfect bliss, you may fancy yourself when there, if not in Paradise, at least not far from the Garden of Eden.

On the 16th we sent up the first instalment of

our stores to the final cone. The weather was very bad, with a varying temperature, and I did not go up till the 18th. The view from our camp extended over a large expanse of country, cut up by cracks and fissures, in every direction covered with cinders and blocks of larva. It seemed curious that although the cone, for at least six or seven miles in all directions, was covered with lumps of scoriæ, which, from the manner in which it was dotted about, appeared to be ejected from the crater, I could not learn that an ebullition of any considerable volume had ever been witnessed on the part of the natives. Some ridiculed the idea that they had ever been thrown out; yet in respect of fire, water, and ashes, everyone had something to say. They generally agreed in stating that flames were frequently seen to rise above the rim of the crater, and that even when the larva is not flowing, and ashes are not being ejected.

On the morning of the 18th, we started before daybreak, and at half-past six arrived at the edge of the crater. We had so far improved in condition, that when between 18,000 and 19,000 feet, we made 360 steps without stopping, and only halted then because our men were tired. The ascent cannot be said to present any difficulties; we passed almost the whole way over snow up to the final cone, and then over ash mixed with ice. This final cone is the steepest part of the ascent, and on our side presented an almost continuous angle of 36 degrees.

We advanced, and from a few feet of the edge itself, we had to peer into the unknown. A vast quantity of smoke and vapour was boiling up, and we only saw at intervals a portion of the opposite side, the bottom being invisible. We then returned to make a place for the tent, with the assistance of the natives. When this was done, we sent them back to the first camp, and the Carrels and I remained alone. The camp was necessarily established on the outside of the final cone, which, at this time, was entirely composed of ash. This was very warm to the touch, and so loose as to render it a matter of much trouble to fix the tent ropes, and a high wind springing up, we carried out four additional ropes, and attached them to the largest stones we could find, and bury in the ashes. We then rigged up a rope, as a sort of hand-rail, from the tent immediately to the edge of the crater, from which it was distant about 250 ft. We had scarcely completed the operation, when a violent storm arose, which threatened to carry our whole establishment away. The poles of the tent quivered, the ropes dragged, and it was a question whether the tent would weather the squall. But the storm passed away as suddenly as it arose, and for the rest of our stay we were not much troubled by the wind. While this was going on, we had another cause for alarm. A great smell of india-rubber commenced to arise; and putting my hand to the floor of the tent, I found it was on the point of melting; and placing a maximum thermometer on the floor it rose to 110°. As my feet did not feel at all warm, I tried in another place, and found on the other side of the tent it was 50°, and in the middle 72°, whilst outside it was intensely cold, and in the night a minimum of 13° was shown in the temperature.

At intervals of about half-an-hour the crater regularly blew off steam; no stones were observed. The steam appeared to be very pure; it rose in a jet of great violence from the bottom of the crater, and boiled over the edge, continually enveloping us. The noise made on these occasions resembled that which we hear when a large steamer is blowing off steam. We sustained scarcely any inconvenience from it, and this was the more remarkable since we had been well nigh stifled with sulphurous vapour about 1,500 feet from the edge of the crater when coming up. When night had fairly set in, we went up to view the interior, and saw the whole of its vast proportion for the first time. By measurements made on the following morning I find that the rim has a diameter from north to south of 200 feet, and from east to west about of 1,500. The rim is irregular, some points being considerably higher than others. The rock is trap; in the interior the walls descend to the bottom in a series of steps, and a precipitous slope of about a thousand feet. At the bottom there was a nearly circular spot of glowing fire, 24 feet in diameter. In looking at this, it was impossible to say whether liquid lava filled the pipe up to its orifice or not. Flames were flickering and travelling about in all directions, so that what was underneath them appeared more like incandescent than molten matter. The heat at the bottom of the crater was evidently intense, and far up its sides, in every direction, glowing fissures, from which flickering flames were also coming, showed that lava was red-hot below the surface, while columns of steam or smoke rising from hidden orifices, heightened the effect. It is impossible to conceive a more dramatic spectacle than this vast theatre represented, illuminated below by the subterranean fires, and above by a brilliant moon, whilst every now and then these outbursts of steam occurred, rushing upwards with the force of a hurricane, and scattering all around fragments of fused rock. Then—although I had said the steam appeared to be pure—we found in the morning the tent was black with ash which had been ejected. Had we remained on the summit only a short time this would not have been noticed. The fragments were found, on microscopical examination, to be particles of fused rock, and they are, I think, torn off by the violence of the steam blasts. This will be found to be of interest in connection with what you will hear subsequently. I attribute these outbursts to the infiltration of the snow and hail which falls on the final cone. It is almost immediately liquified, and descends into the bowels of the mountain. We noticed while on the mountain, that the whole upper part of the cave was white with snow or hail, and yet in the course of an hour or two it would entirely disappear and descend into the mountain. On one occasion, while on the summit, it hailed so violently as to cover us with an inch of ice, and yet in half-an-hour this entirely disappeared.

The height of Cotopaxi is 19,600 ft. Our camp was placed about 130 ft. below the loftiest point, and was the most elevated position at which any of us had ever lived. We remained there 26 consecutive hours, feeling slightly at first the effects of the low pressure, having the same symptoms as we noticed on Chimborazo; and we used chlorate

of potash, and remarked its good effects. All the signs of mountain sickness had passed away before we commenced the descent, and they did not recur again during the journey. Nearly five months later, we found ourselves again on Chimborazo. I desired to make a second ascent for several reasons, but principally because our stay on the summit, on the first occasion, was too brief to permit us to accomplish our work. Besides, the observations of the barometer were somewhat hurried, and I did not feel sure that the deduced heat established a good determination. If, however, a second reading should accord with the first, it would, besides confirming it, establish confidence in respect of observations made in the meanwhile on other mountains. We were too much laden on the first occasion, but now we had trained two natives into respectable mountaineers in order that they might support us. After ascending a peak, we crossed a depression between two mountains, and encamped in a charming spot, surrounded by butterflies and humming-birds. Next day we mounted up to camp five, which was almost 15,000 feet above the others. My time had nearly expired, and we were delighted by a stroke of great good fortune. Next morning was clear and even cloudless, and we saw long before dawn our old friend Cotopaxi in the far distance, and remarked how tranquil it looked—not a sign of smoke was rising from the great volcano. We went on foot, and before daylight, soon commenced to ascend the ridge which leads continuously towards the second summit. I was in the rear, stopping to heat my numbed hands, and looking towards Cotopaxi, when all at once I saw a column of smoke commence to rise from the crater. It went up straight into the air, rapidly curling with such velocity that within a minute it had risen 20,000 feet above the crater. It was caught by an easterly wind, and borne 20 miles towards the east, at right angles, towards its former course ; it then turned, and a northerly wind carried it towards our position. As the cloud came nearer and nearer to us, it appeared to rise higher and higher in the sky, and about twelve, at noon, it got overhead, and shut out the sun. But before this happened, we witnessed the most extraordinary and startling effects in the atmosphere between us and the volcano—a thick cloud, sometimes like shining brass, then turned to tarnished copper, or the most extraordinary green, producing a feeling of intense astonishment, which could not be banished. In the curled openings in the clouds that arose after the commencement of the eruption, I still saw a majestic column of ash pouring out, and rising to an immense height in the air, blacker than the deepest ink. As we were engaged in the ascent of Chimborazo, and had many other things to occupy our attention, we did not appreciate at first the magnitude of the eruption, but when we got on the summit, and found the ash beginning to fall to such an extent that the snow looked like a ploughed field, we perceived something out of the common was happening. We arrived on the summit at 20 minutes past 1 on this occasion, and had the satisfaction of finding the end of a flag staff, which had been put up on the first occasion, still appearing above the snow. You will readily believe that I referred to the barometer with no little eagerness, and this time it read 14·28 in an air temperature of 15° Fahr., which gave for the height of Chimborazo, 20,489 feet, or 56 feet less than on the first occasion, the mean of the two deductions being 20,517.

When we returned to our tent on the 5th of October, we found it laden with ash from Cotopaxi. It was still falling, and covered the country all round as with a dense fog. I collected more than three ounces from the tent, but this was not half that which was upon it, and much more slipped off down the sloping sides. I subsequently found, in the town of Ambato, 20 miles nearer the mountain, between 11 o'clock and 11.15, upon a piece of paper spread to receive it, one foot square, four ounces were collected, and from these data I have made a calculation that the minimum quantity which must have been ejected, drawing two lines from Cotopaxi, one leading to Riobamba, 20 miles to the east of our station, and another on a line as far to the west, within which limits I am certain this ash was falling, at least two million tons of this ash must have been ejected during this eruption. The quantity is under-estimated in a variety of ways. The ash was carried beyond the limits indicated, and I believe it fell over many hundred square miles further. The quantity taken into account was that actually found on the tent, but from Ambato, northwards, that quantity only is reckoned to fall in a quarter of an hour. Professor Bonney has recently submitted this to microscopical examination and, estimating the size of the particles, we find the ash which fell on our tent at the summit of Cotopaxi was so exceedingly fine that 4,000 particles scarcely weigh a grain. That which fell upon it when on Chimborazo was much finer, and in estimating that 25,000 particles go to a grain we are well within the mark. They bear a strong family resemblance to one another, and consist principally of glassy felspar, and of long crystalline scoreous dust. It is certain that that which fell on us on the summit was torn off by the steam blasts to which allusion has been made, and I conclude that the matter which was ejected during the other eruption was torn off and thrown out by a continuous blast of almost inconceivable violence.

If you can picture to yourselves the force which is required to eject two millions of tons of this ash (so light that 25,000 particles scarcely weigh a grain) to a height of four miles in the air upwards from the crater, and to send it up vertically, unaffected by the east wind, you may be able to form some idea what a terrible creature Cotopaxi is in his more furious moments.

This, ladies and gentlemen, brings my remarks to a close, and, in conclusion, permit me to say a word more in respect to mountain exploration in general. Amongst certain persons it is still fashionable to affect a description of scorn, bordering on contempt, for anything in connection with mountains and mountain work. None of us feel, perhaps, very deeply the criticism of those who are individually ignorant of the subjects on which they talk, and for this matter speaking for myself, I rather look forward to the time, which will surely come, when the study of mountains, the ascent of mountains, and even prolonged residence on mountains, will

be found essential for the prosecution of a score of sciences. Before this could be carried out, it was necessary to learn whether life could be made endurable at great heights. We were always haunted by the fear of an invisible enemy who might strike us down at any moment. What we wanted to know was, not whether life could exist at a height of 20,000 feet; that was settled 75 years ago, by Goy Lussac; but whether man could become so far habituated to the low pressure which is experienced at that height, as to be able to live without inconvenience, and to do useful work. I went to the Andes in search of the answer to this question, and having heard the story, you can form an opinion whether it affords an encouragement for the prosecution of exploration in other quarters. There is, I think. no department of travel more fascinating than mountaineering. Mountains present the grandest natural features, they will be always equally attractive near or far, in cloud or in sunshine; their wonderful variety of outline, their startling contrasts of colour, and their dazzling effects, have ever been sources of inspiration for poets and for painters. They afford perpetual instruction to the geologists, and they will, no doubt, one day throw a light on those great questions touching the origin and distribution of species which have so much exercised the ingenuity of botanists and zoologists during recent years. Mountains affect climate, give birth to rivers, have fixed the boundaries to kingdoms, and have determined the limits of races; they have often wrecked the ambition of the invader, or sustained the hopes of the patriot; they form some of the best material guarantees for the peace of the world. So far from being inclined to take a low view of the usefulness of mountaineering, I hold that the study and the exploration of mountains is of the first importance for the purposes of political and physical geology.

The Chairman then proposed a cordial vote of thanks to Mr. Whymper, which was carried unanimously.

MISCELLANEOUS.

CULTIVATION OF CAOUTCHOUC TREES IN INDIA.

In Mr. Markham's recently published "Peruvian Barks," there is an appendix on the above subject, and from this and other sources the following account has been drawn up by Mr. James Collins.

In January, 1868, a paper appeared in Dr. Seemann's "Journal of Botany," on "The Commercial Kinds of India-rubber or Caoutchouc." by Mr. Collins. This paper was, for the most part, a *résumé* of what had been written on the subject, and also contained the results of personal observations on the preparation and commerce of that article, together with an endeavour to fix the botanical sources of the various varieties.

At the instance of Mr. P. Le Neve Foster, and the distinguished botanist and traveller, Dr. Seemann, the author of this article followed up the subject, and the result of his further researches were given in a paper, entitled "India-rubber; Its History, Commerce, and Supply," read before the Society in December, 1869. The concluding remarks in this paper are as follows:—

"There is one subject which I would more especially recommend to the attention, not only of those present, but also submit to the attention of her Majesty's Government, that is, the acclimatisation of the different species of *Hevea* (and also incidentally, I would mention the species of *Isonandra*, which yield gutta-percha) in such of our own eastern possessions, as will be found best suited."

Owing to the prominence thus given, the subject of the introduction into, and cultivation of, caoutchouc trees in India was not allowed to drop, and through the representations of Mr. Markham, Mr. Collins was commissioned to prepare a report on the subject for the Secretary of State for India. This "Report on Caoutchouc" was published in 1872. The following passage from it may be quoted here:—

"The cultivation of economic plants, and the acclimation in localities where the various conditions, which are so many elements of success, are more controllable than in their native habitat, has a very important bearing on the commerce of a country, and becomes the more necessary for the sustentation and improvement of trade and manufactures, as the march of civilisation and colonisation or the recklessness of native collectors reduce the area and number of spontaneous forest products. It may be taken as an axiom beyond all controversion, that we cannot long rely on the spontaneous products of the forests, but that recourse must be had, sooner or later, to conservation, cultivation, and acclimatisation in order to keep up supplies of all necessary vegetable products."

The recommendations were that the (1) *Heveas*, yielding Para caoutchouc; (2) the *Castilloas*, Central American caoutchouc; (3) the *Vaheas*, Madagascar caoutchouc; (4) the *Landolphias*, African caoutchouc; and (5) the *Urceola elastica*, Borneo caoutchouc, should be introduced into India; and that the cultivation of the indigenous *Ficus elastica* should be forthwith attended to. Of the various plants mentioned, the relative values of their products were taken into consideration, the *Heveas* and *Castilloas* being specially mentioned.

These views were adopted, and steps taken to carry them into effect. Meanwhile, Mr. Collins sent out full instructions to a correspondent on the Amazons, and was fortunate enough to obtain seeds of the *Hevea Braziliensis*, and plants raised from these seeds at Kew, were taken by Dr. King to India, in 1873. Thus India obtained her first Para caoutchouc plants. A still larger supply was collected and brought home by Mr. Wickham, in 1876.

Still, not only were seeds and plants to be obtained, but, as was pointed out, there were many questions to be cleared up. Further information was wanted on the physical and climatic conditions under which the trees best flourished, and the best methods of preparing the caoutchouc, &c., and for this purpose observations on the spot were absolutely necessary. In the selection of a proper person, Mr. Markham was so fortunate as to secure the services of Mr. Robert Cross, whose previous travels in search of Cinchona plants, and his knowledge of the country and languages, eminently fitted him for the task.

Mr. Cross left England for Panama Isthmus, in May, 1875, and first searched for Castilloa plants, yielding the well-known Central American caoutchouc. The species which he first met with proved to be the *Castilloa Markhamiana*, so named by Mr. Collins in honour of Mr. Markham. This species grows to a height of 160 to 180 feet, with a diameter of about five feet, and a full grown tree yields about 100 lbs. of caoutchouc. The wood is soft and spongy, and rapidly decays. Some caoutchouc prepared from these trees by Mr. Cross was reported to be superior in quality to that yielded by the historic *Castilloa elastica*. The range, too, of these trees

was so wide that in certain districts part of the year is dry. Of the plants collected, 134 flourished at Kew, and of these a goodly supply was forwarded to India in 1876.

Mr. Cross again left England in 1876, this time to procure seeds and plants of the Ceará caoutchouc tree, and further supplies of the Heveas. In both efforts he was successful, resulting in the establishment of 1,000 plants of *Hevea Braziliensis*, and a goodly number of Ceará plants, all in fine condition at Kew.

The tree yielding Ceará caoutchouc, till this time, was unknown, and to Mr. Cross is due the honour of clearing up its origin. In trying to get up young plants he could not move them, till digging round the roots he found them furnished with tubers of the size and shape of kidney potatoes, and from materials brought home, the plant is recognised as the *Manihot Glaziovii*, a near relative of the tapioca plant. Quotations from Mr. Cross's report on this journey have already been published in this *Journal* (July 12th, 1878), and the report is full of practical information of the utmost cultural value.

Mr. Markham sent the bulk of these plants to Ceylon, from whence, as he says, they can be distributed to suitable spots in India as soon as the Government are less lukewarm on the subject, and fully recognise the importance of the scheme. In Ceylon, the Heveas grow remarkably well, and some trees have reached a height of nearly 30 feet, with a girth of 14 inches. The Castilloas also do equally as well. Later information from Ceylon shows that private planters are taking up the question, and Dr. Trimen, the newly-appointed director of the Peradeniya Gardens has published for their use a series of instructive notes on the cultivation, based on the reports of Messrs. Collins and Cross.

As to Madagascar caoutchouc plants very little information is to hand. Mr. Markham mentions (*Journal of the Society of Arts*, April, 1876) that seeds of *Vaheæ* have been sent to India.

With regard to African varieties, Dr. Kirk has displayed much interest, and has procured many plants of the Landolphias. Mr. T. Christy has procured several plants of *Landolphia florida* and *Urostigma Vogelii*, as well as plants of an apparently new kind from East Africa, yielding an excellent quality of caoutchouc, and some fine and healthy examples of these are now in that gentleman's nursery.

Thus of the various introduced kinds it is pointed out that the Heveas produced the choicest and best caoutchouc, and are well fitted for the moist zones of India. Castilloas will grow over the largest area, and new homes can be found for them in the Western Ghâts. Ceará kind thrives on drier ground, and may find a fitting home in the hot dry plains of India.

In the efforts to introduce these exotics into India, the primary recommendation to cultivate and conserve the indigenous *Ficus elastica*, yielding Assam caoutchouc, has not been lost sight of. The first attempts, commenced in 1873, were comparative failures; but since that date the superintendence has been placed under Mr. Gustav Mann, and under his able management the experiment begins now to assume some importance, and, roughly speaking, there are now 1,000 acres in Assam under this cultivation, and the trees are making vigorous and excellent progress.

One other plant deserves notice—a Burmese one—as likely to prove of great utility as a source of caoutchouc. It is the *Chavannesia esculenta*. This plant, of a climbing habit, was always looked upon as a pest by the forest department of British Burma, and every means taken for its extirpation, as it injured the teak trees. Mr. Strettell, one of the officers, however, discovered that it contained caoutchouc, and seems to have proved conclusively that it will repay cultivation. If this turns out to be the case, it will only be another exemplification of the fact, that "a weed is an unutilised plant."

Thus, although but yet in its infancy, the subject of the acclimatisation and conservation of caoutchouc-yielding trees has arrived at such a stage that its practicability is placed beyond all doubt, and the Society may well congratulate themselves that the warm support accorded to the idea when first brought before them, has proved an important factor in the present state of affairs. Nor must the action of Kew be forgotten. The valuable aid and support given to Mr. Collins by Sir Joseph Hooker, and the great care he has bestowed on seeds and plants sent to that establishment, have been of the utmost practical moment.

As Mr. Markham says:—"This, if intelligently and continuously followed up, will thus ensure in the future, as the demand increases, a regular and large supply of the best kinds of caoutchouc from British India."

FRUIT GROWING IN THE UNITED STATES.

Consul Cridland, in a recent report, states that East Florida has very great natural advantages for fruit growing, and especially for the orange and lemon, fruits peculiar to warm climates. Large districts in the countries situated between the latitudes of 27° and 29° 40′ north, and longitudes 80° 30′ and 82° 40′ west, seem to be particularly adapted to the orange and lemon tree, and little else is profitably grown on such land. Formerly, in Florida, as in most of the cotton States, the whole time and attention of the people was engrossed in the cultivation of the cotton plant and the sugar cane. Fruit growing was looked upon rather with contempt, and no value was attached to the wild orange groves in the State, any more than to the same quantity of other timbered lands. In fact, very frequently the wild orange trees were cut down and destroyed to make room for cotton and sugar. Of late years, however, the people have found out the importance and profits of tropical fruit culture, and the old wild orange trees are highly prized, and are converted into sweet oranges by grafting. The difficulty in regard to orange culture is the impatience for immediate results. The orange, if cultivated from the seed, requires from seven to ten years of attention before it begins to bear, and the lack of patience and confidence deters people from starting an orange grove, and persisting in its care. Experience has proved that there is no fear of frost south of Pilatka. The quality of the Florida orange, and the excellent condition in which it reaches the northern markets, renders it a most profitable crop. There can be no fear of an over-production of the orange or lemon when it is considered what a vast country has to be supplied. In 1879, 4,000,000 dollars' worth of oranges and lemons were imported into the United States, and the orange crop of Florida was valued at over 1,000,000 dollars. From information lately published in the United States, it is estimated that the orange crop in Florida next season will be 100,000,000 of oranges, for which the dealers will give the growers 1,500,000 dollars. The orange crop will double itself every three or four years; and considering that the reports to the Governor show that there are over 20,000,000 of trees in the orange groves of Florida, in future years the crop will be enormous, and exceedingly profitable, and if the 20 per cent. *ad valorem* duty continues, it will stop the importation of oranges from Sicily, Spain, and the West Indies. Persons who engage in the cultivation of an orange grove in those parts of Florida where frost is almost unknown, proceed there and purchase from five to ten acres of land. Suitable land for orange culture costs from 15 to 20 dollars per acre. The land is then fenced in, which can be done for 6 dollars per acre. Clearing the trees and grubbing the roots, if done thoroughly, will cost 20 dollars pe[illegible] his work takes some

months to accomplish. Persons are found who undertake not only to clear, grub, and plough the land, but to purchase the orange trees and set them out. Most people purchase and replant trees three years old. From 60 to 80 trees are planted per acre; to plant and set out 300 trees would cost 200 dollars. In two months after being set out, which is generally done in January or June, the trees are fertilised with guano; the ground ploughed heavily once a year, and lightly six times a year. A crop of Southern peas is raised between the trees, and, when ripe, ploughed in to enrich the soil. The trees receive two applications of guano a year. They grow little the first year; after that they become firmly established in the soil, and grow faster. There are no serious diseases of the orange, in good soil, in Florida. There are a great variety of orange trees, but none so good as the Florida seedlings, or native trees. In starting an orange grove, the land should be cleared of everything, and well broken up. The holes for the orange seedlings should be 30 feet apart, and 18 inches deep, and four feet in diameter. Consul Cridland states that for a total outlay of 1,030 dollars, a person can have an orange grove in Florida which will, after the fifth or sixth year, begin to yield a good income.

THE PEASANT POPULATION OF SERVIA.

The population of Servia is about 1,750,000, of whom nine-tenths are peasants, living entirely from agriculture; 60 per cent. of the Servian villages range from 50 to 500 inhabitants per village, and 25 per cent. range from 500 to 1,000 per village. It follows, therefore, that the peasant population is very much scattered, though in the valleys, villages are not widely distant from each other, and it may be divided into two schools, the old and the new. The peasant of the old school lives and cultivates his land in the most primitive manner possible, whilst the peasant of the new school is (as a result of the national system of education, under which a school is now to be found in every considerable village) more advanced on the path of civilisation. The peasant of the old school lives in a cottage with mud floors and mud walls; his live stock consists of a yoke of oxen, half-a-dozen pigs, and a small flock of sheep and goats, his plant comprises a wooden plough, costing about one ducat (10s. sterling), a waggon built entirely of wood (not a particle of iron entering into the construction of either waggon or wheels) which cost about three ducats, or 30s.; a sekira (an axe weighing about 10 lbs.); with which he executes the repairs required for the house or the plant; half-a-dozen hoes for the maize and the vineyard, and half-a-dozen pruning hooks for the vines; several large barrels for wine and rakija, and a few large earthenware vessels for his goats' and sheeps' milk. The oxen draw the plough, and he himself guides it, but almost all the rest of the field work is done by his wife and daughters. The thrashing of the corn is achieved thus:—A piece of ground about 40 feet in diameter is well trodden down, and a large stake is driven in in the middle; a pony is borrowed or hired from a neighbouring carrier, and is attached by a long cord to the stake, the corn in the straw is spread over the ground, and the pony is driven round and round till he has wound the cord round the post, he is then driven in the opposite direction till he has unwound and re-wound the cord, and this is repeated till the corn is more or less thrashed out of the straw. The winnowing is very simple and very imperfect, it being done by the wind. The peasant with a wooden shovel throws the corn high up into the air against the wind, which is supposed to carry away the chaff. The clothing of the peasant of the old school is, with the exception of his fez, nearly all home-made; his wife and daughters spin and weave the cloth of which his shirt, his coat, his "tchaksheri" (broad pantaloons), and his stockings are made. His "opantzi" (sandals) are often made by himself, and his winter coat and cap are generally of sheepskins from his own flock. But the peasant of the old school is rapidly being superseded by the modern Servian peasant, who dates back from the year 1832, when Prince Milosh founded at Kragujewatz the first Servian gymnasium, which was followed in 1843 by a General Education Act, under which, and subsequent Acts, education became general and free, no fees of any kind being payable by the pupils. This might, at first sight, appear to have very little connection with agriculture, but education has exercised a very material influence on the Servian peasant; it has improved his mode of life and his method of cultivation, so that he produces more and spends more, thus contributing more to the exports, and raising the imports of the country. The peasant of the new school builds his house of stone or brick, and furnishes it with a view to comfort, if not to luxury; his land is farmed, too, with some regard to scientific principles, his plough is of modern construction, often entirely of iron and steel. His favourite plough is of wood and iron, for 12-inch ploughing, weighing, with the fore carriage, about 130 lbs., and costing at Pesth about five ducats, or £2 10s., but, on account of the difficulty of transport, there being a total absence of railway communication, only 400 to 500 ploughs are imported annually into Servia, and these are to be found chiefly in the vicinity of the Danube. The modern school of peasants understands, too, the advantage of thrashing by machinery, and a hand-thrashing machine of iron and wood, weighing about 450 lbs., and costing about 25 ducats, or £12 10s., at Pesth, is not unfrequently to be found among his plant; as also a hand-winnowing machine, weighing about 300 lbs., and costing about 10 ducats, or £5, and a maize-rasping machine, for separating the maize grains from the stalk, weighing about 200 lbs, and costing about 10 ducats, or £5. But the interior transport difficulty restricts the import of these machines in common with that of all heavy goods. The modern school of peasants, although clinging to the national costume, with regard to pattern and fashion, is rapidly adopting Western woollen and cotton manufactures as the materials for his clothing, and that of his wife and family, and this fact cannot fail to have a large and increasing influence on the import of woollen and cotton textile manufactures into Servia.

PLANT-LABELS.

The Rev. C. Wolley Dod, of Edge-hall, Malpas, writes to the *Gardeners' Chronicle*, as follows:—

"On going round the herbaceous garden at Kew, it has often occurred to me that the labels are taken up and laid together every time a bed is raked, and afterwards replaced by the labourer from memory, the evident transpositions having seemed difficult to explain in any other way. But after the experience of this winter, when nearly all our flat wooden labels are not only out of the ground, but appear to have been shot out, something in the way in which I have seen porcupines at the Zoological Gardens shoot out their loose quills, so as to be at a distance from the plant which they marked, any amount of demoralisation in the naming of mixed borders can be easily understood. Hence the subject of labels is not unnaturally attracting a good deal of attention at present.

"It may help those of inventive genius who are going to compete for the prize for the best plant-label offered by Mr. G. F. Wilson, through the Society of Arts, if hints are sent by those who have tried different

kinds of labels, so as to give the competitors the full benefit of all past experience. I assume that in all mixed collections of plants a large number of labels is necessary. In my garden, which is of moderate size, I label nothing which can be recognised at all times of the year without a label, and yet I have fully 10,000 labels in constant use. Labels should be (1) cheap, (2) durable, (3) indelible, (4) portable, (5) markable with a common lead-pencil, (6) not liable to be ejected by frost, or (7) broken by a kick.

"Those who have plenty of hazel trees at hand will find hazel rods, three quarters of an inch in diameter, cut into lengths of about 10 inches, with an horizontal slice cutting into 4 inches from the upper end, and made by a single cut of a knife, to take the paint for writing, in many ways better and cheaper than the common flat labels. They last three times as long, or more if the lower end is dipped in creosote. A common labourer with plenty of material, using a pair of pruning-shears and a strong sharp knife, will easily cut 1,000 in a day, and they possess qualities 4, 5, 6, and 7.

I have, however, invented and adopted another label—clumsy I admit, and not readily commending itself to others, but far more simple in practice than it sounds in description. It reminds me of the military regulation order explaining the cocking of a musket, or printed directions given for learning to swim. What reads and sounds as if it were difficult and complicated, becomes in practice the simplest thing in the world. Common round bar-iron, three-eighths of an inch in diameter, is cut obliquely into lengths of 10 inches, and pierced with an eye ¼-inch from one end, and dipped when red-hot into gas-tar. For these pegs, which weigh about 4 oz., I pay 50s. per 1,000, but think they might be had for less. Then I have flat wooden suspending labels pierced at each end, for which I pay 4s. 6d. per 1,000; through the two eyes 8 inches of pliant wire is passed, for fastening the label to the iron pin. These are, upon the whole, the most satisfactory labels I have yet used. They cost 5s. 6d. per 100, but the iron pin—nine-tenths of the cost—is indestructible. The label is easily and quickly renewed, and will last, when suspended, for many years. Not one has been ejected from the ground this winter, and if kicked over they are not hurt, and easily set up again. It is true they are heavy to carry about, but I keep a stock of the pins, which are weather-proof, in various corners, so as to have them handy for all parts of the garden.

"Then the wired labels are just as portable and as easily written on as common flat wooden pegs. My great desideratum is a white paint which will reject the splashing of mud, but retain for ever the writing of a lead-pencil. I can get no paint which is perfectly smooth and not sticky when dry, and should be thankful to be told of any. I enclose specimens of what I have described.

"I may add that a heavy plant-label is not altogether without its advantages. In the year 1842, when I was a boy at Eton, one of the many jackdaws which built in the college chapel insisted upon having her nest so arranged that she could, whilst sitting, see out of the turret loophole, which looked towards Windsor Castle. This could only be done by making the foundation on a step of the spiral staircase, nine feet below; and a massive nest, nine feet high, was accordingly built. I made friends with the college clerk, and watched the progress of the nest, and recollect that amongst the materials, besides there being a box of lucifer-matches, garden pegs seemed to be in great request. Three or four years later, when I was at Cambridge, I recollect the present Professor of Botany exhibiting, at a meeting of the Ray Club, a newly-devised label for use in the Botanic Garden there. It was a very heavy metal one—the weight, he said, being found necessary to prevent the jackdaws carrying them up for their nests between the roofs of King's College Chapel."

NOTES ON BOOKS.

Electro-typing. By J. W. Urquhart. (London, Lockwood and Co., 1881.)

This book is of a similar character to the other little manuals which have been issued by the author, on some of the practical applications of electricity. His object throughout is to make himself intelligible to persons who have not much knowledge of science. The early chapters deal with the metals employed and the sources of electricity, describing not only the usual batteries, but also some of the machines now so largely used for electro-plating purposes. Electro-type solutions, depositing-vessels, moulding materials, &c., are all treated in succession, while the concluding chapters of the book deal with the preparation of the work and methods of treating it after the electro-type process is complete.

The Expiring Continent. By A. W. Mitchinson. (London: W. H. Allen and Co., 1881.)

Under this title Mr. Mitchinson gives an account of his travels in Senegambia. Mr. Mitchinson passed some time travelling in that country and associating with its people, so that he was in a position to accumulate valuable information about them. His chief object was to take notes of the manners and customs of the people, and of the natural productions of the country through which he travelled. As was the case in the paper which he read before the Society last year on "The Principal Causes of Disease in Tropical Countries," Mr. Mitchinson devoted considerable attention to sanitary questions, and frequent observations upon them occur throughout the work. The book has a number of illustrations, and also contains a map of the districts traversed.

Water: its Composition, Collection, and Distribution; a Practical Hand-book for domestic and general use. By Joseph Parry. (London, F. Warne and Co.)

The subjects of the chapters into which this book is divided are, the composition of water and sources of supply, purification, modern waterworks, distribution, waste, rural supplies, domestic supplies, water for trade purposes, and regulations for the prevention, waste, and misuse of water. Chapter 6 contains an analysis of water rents, rates, and charges, with a table of the rates charged per annum for domestic supplies in the chief towns of Great Britain.

The Wild Silks of India, principally Tusser. By Thomas Wardle, F.C.S. (London, Eyre and Spottiswoode, 1880).

This is a reprint by the Government of Mr. Wardle's paper, read before the Society of Arts, and printed in the *Journal* for May 9, 1879.

OBITUARY.

Professor Tennant, F.G.S.—By the death of James Tennant, on the 24th of February last, at the age of seventy-three years, the Society of Arts loses an old and active member. Mr. Tennant was the assistant, and afterwards the successor, of J. Mawe, author of "Travels in Brazil," and of a "Treatise on Diamonds," whose original series of minerals formed a nucleus for the large collection of metalliferous minerals, geological specimens, and fossil remains, which Mr. Tennant eventually gathered together. Mr. Tennant also possessed a rich collection of precious stones, of which the Devonshire collection formed an important

part. He was, for many years, Professor of Geology and Mineralogy at King's College; London, and after resigning the Professorship of Geology he retained the post of Professor of Mineralogy, which he held at the time of his death. In conjunction with the late Professor Ansted and the Rev. W. O. Mitchell, he wrote, in 1857, the "Treatise on Geology, Mineralogy, and Crystallography" for "Orr's Circle of the Sciences." He was also the author of descriptive catalogues of fossils, and of popular lectures on the sciences in which he was specially interested. Mr. Tennant was an energetic member of the Turners' Company, and took special interest in the action of that company for extending Technical Education. He was elected a member of the Society of Arts in 1846, was a constant attendant at the meetings, and frequently joined in the discussions, besides reading a paper on "South African Diamonds," on November 23, 1870.

GENERAL NOTES.

Fire Extinction.—A public exhibition of Dick's "Extincteur," and brigade chemical fire-engine, "Excelsior," was held on Tuesday, 8th inst., on a piece of large waste land in Whitehall-place. A fire of wood saturated with petroleum was lighted, and then immediately extinguished by these engines.

Sanitary Assurance.—Dr. F. de Chaumont, F.R.S., will deliver a lecture on "Sanitary Assurance" at the London Institution, Finsbury-circus, on Tuesday, March 15th, at 8 p.m., in connection with the Sanitary Assurance Association. The chair will be taken by J. Eric Erichsen, F.R.S., President of the Royal College of Surgeons. Members of the Society of Arts will be admitted to the lecture on showing their cards.

Madrid Fine Art Exhibition.—It is proposed to hold a series of Fine Art Exhibitions at Madrid, to which Spanish and foreign artists may alike contribute. Works belonging to any of the following categories, which have received the approval of the jury, will be admitted:—(1) Paintings, including stained glass, lithographs, wood engravings, and etchings; (2) Sculpture; (3) Architecture; (4). All works which, although not expressly included under any of the foregoing headings, may be considered by the jury, on account of their artistic merit, worthy of a place in the Exhibition. Works by deceased artists will not be admitted. An exhibition will be held at intervals of three months, commencing in the month of April. Each exhibitor may present an unlimited number works of each class. There will be a gallery in the Exhibition set apart for those works which have not been accepted by the jury, but whose authors are, nevertheless, desirous of exhibiting them to the public. Information can be obtained by intending exhibitors at the office of the Spanish Legation, 12, Queen's-gate-place, S.W.

Edinburgh School of Cookery.—The fifth annual meeting of the Edinburgh School of Cookery was held in the hall of the school, Shandwick-place, Lord Provost Boyd presiding. The Secretary (Miss Guthrie Wright) read the annual report of the Executive Committee, from which it appears that, during the session 1879-80, the usual courses of lessons in high-class, plain, cheap, and sick-room cookery were given in the school. Classes were held in various institutions and schools, and two demonstrations on sick-room cookery to medical students, in the class-room, Minto-house. In addition to the ordinary pupils, the following have received instruction in the School of Cookery and Domestic Economy:—Thirty-one nurse probationers from the Royal Infirmary; eleven girls from Lauriston-lane Home; seven girls from Young-street School; branch public classes were, on application, given in Leven and in Portobello. In developing the institution into a school of domestic economy, the committee aim chiefly at providing such teaching as will render women efficient and useful in their homes. The funds show an income during the year of £2,917 3s. 7d., including a sum of £1,760 17s. 4d. of funds and cash balances brought from the previous year. The year's expenditure has been £944 4s. 9d., leaving funds and cash balances on hand of £1,972 18s. 8d.

Royal Albert Hall.—The annual general meeting of the members of the Royal Albert Hall Corporation was held on Saturday, 26th February, at the hall, South Kensington, the Right Hon. Lyon Playfair, M.P., in the chair. The Chairman, in moving the adoption of the report, said it was gratifying to the council to have been able to reduce the hall debt by £1,190, although this had been accomplished rather through the kindness of their creditors than any surplus of money in hand, Messrs. Burchell, their solicitors, having taken six seats at the par value of £100, which was much more than their selling value. They would again find it necessary to ask for a seat-rate of £2 for the current year. They were keeping the hall in a very efficient state of repair, but the profits of the hall had not yet enabled them to dispense with that rate. During the year they had an exhibition of fine arts, and its success justified them in recommending another exhibition in the present year. The Council of the Society of Arts also proposed, in connection with the fine art exhibition, to have an art industrial exhibition, and invited art workmen, manufacturers, and others to submit such works in all materials. The formation of a road between the Kensington nnd Exhibition roads would increase the facilities of access to the eastern entrances of the hall, but even then the approaches would not be all that the council could desire with the view of increasing the attendance at the hall. The system of lighting the hall by electricity had been experimented upon during the year by Messrs. Siemens Brothers, without cost to the corporation. Messrs. Siemens had repurchased part of the apparatus for £310, and as this means of lighting became more perfected they hoped, with the machinery they had retained, to be able to adopt it at a trifiing cost. Mr. G. Godwin, in seconding the motion for the adoption of the report, stated that the council would be very glad if the members interested the outside public and the seatholders in the success of the exhibition organised by the Society of Arts. Sir Henry Cole observed with regard to the fine art exhibition that it would probably include a large number of pictures which the Royal Academy had intimated they would have accepted had there been room. The report was unanimously adopted, and subsequently resolutions were passed requesting the Prince of Wales to act as president of the hall, and re-electing the retiring members of the council.

THE LIBRARY.

The following works have been presented to the Library:—

Some Particulars with reference to the Concession for the Construction of the Great Andino-Argentine Railway, from Mercedes to Mendoza and San Juan. (London, 1879.) Presented by Mateo Clark.

Solutions of the Questions in Magnetism and Electricity, set at the Preliminary Scientific and First B.Sc. Pass Examinations of the University of London, from 1860 to 1879, by F. W. Levander, F.R.A.S. (London: H. K. Lewis, 1880.) Presented by the publishers.

The Signature of Gutenberg, by P. de Villiers, M.D. (London: Kerby and Endean.) Presented by the author.

Hastings as a Health Resort, by P. de Villiers, M.D. (Hastings, 1879.) Presented by the author.

Water: its Composition, Collection, and Distribution, by Joseph Parry, C.E. (London: Frederick Warne and Co., 1881.) Presented by the publishers.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

MARCH 16.—"The Beaumont Compressed-Air Locomotive. By Col. F. BEAUMONT, R.E.

MARCH 23.—"The Increasing Number of Deaths from Explosions, with an Examination of the Causes." By CORNELIUS WALFORD.

MARCH 30.—"Recent Advances in Electric Lighting." By W. H. PREECE.

April 6.—"The Discrimination and Artistic Use of Precious Stones." By Professor A. H. Church, F.C.S.

April 27.—"Five Years' Experience of the Working of the Trade Marks' Registration Acts." By Edmund Johnson.

Dates not yet fixed:—

"The Manufacture of Glass for Decorative Purposes." By H. J. Powell (Whitefriars Glass Works).

"Buying and Selling; its Nature and its Tools." By Professor Bonamy Price, M.A. Lord Alfred S. Churchill will preside.

"The Electrical Railway, and the Transmission of Power by Electricity." By Alexander Siemens.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

March 15.—"Diamond Fields of South Africa." By R. W. Murray.

April 5.—"Canada; the Old Colony and the New Dominion." By E. Hepple Hall.

May 10.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

March 24.—"The Future Development of Electrical Appliances." By Prof. John Perry.

May 12.—"Recent Progress in the Manufacture and Applications of Steel." By Professor A. K. Huntington.

Indian Section.

Friday evenings, at eight o'clock:—

March 25.—"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

Syllabus of the Course.

Lecture II.—March 14.

The measurement of electric currents. Efficiency of magneto- and dynamo-electric machines. Heating effects of the current.

Lecture III.—March 21.

Use of magneto- and dynamo-electric machines for electric lighting. Electric lighting by means of the arc.

Lecture IV.—March 28.

Subdivisions of the electric current. Incandescent lamps. Luminous effects of electric currents in a vacuum, and in various gases.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 14th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Professor W. G. Adams, "The Scientific Principles Involved in Electric Lighting." (Lecture II.)

British Horological Institute, Northampton-square, E.C., 7 p.m. Mr. John Standfield, "Cheap Patents and Prosperity."

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. James Stewart, "Lake Nyassa and the Water-route to the Lake Region of Africa."

British Architects, 9, Conduit-street, W., 8 p.m. Special General Meeting to elect Royal Gold Medallist, and to receive Council Report on Medals.

Medical, 11, Chandos-street, W., 8½ p.m.

London Institution, Finsbury-circus, E.C., 5 p.m. Mr. G. Phillips Bevan, "The Gold and Silver Mines of the World."

Tuesday, March 15th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. R. W. Murray, "The Diamond Fields of South Africa."

Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. A. Schäfer, "The Blood." (Lecture IX.)

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Renewed discussion upon Sir William Thomson's paper on his "Tide-gauge, Tidal Harmonic Analyser, and Tide Predicter." 2. Mr. David Phillips, "The Comparative Endurance of Iron and Mild Steel when exposed to Corrosive Influences."

Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. Hyde Clarke, "The Progress of the English Stations in the Hill Regions of India."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Zoological, 11, Hanover-square, W., 8½ p.m.

Wednesday, March 16th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Colonel F. Beaumont, "The Beaumont Compressed-Air Locomotive."

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. "Exhibition of Hygrometers and of such new Meteorological and other Instruments as have been brought out since January 1st, 1880." 2. "Historical Sketch of the different classes of Hygrometers," by the President, who will also describe such forms as are exhibited.

Public Analysts, Burlington-house, W., 8 p.m. 1. Mr. C. Heisch, "The Swedish Acts for regulating the Sale of Poisons." 2. Mr. Bernard Dyer, "Some Analyses of Milk." 3. Mr. J. West Knights, "A new method for the Estimation of Nitrates in Potable Water." 4. Mr. J. Carter Bell, "Samples of Milk which have fallen below the Society's Standard."

Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Dr. James Stevens, "Recent Discoveries at Reading." 2. Mr. Henry Prigg, "Roman Pottery Kilns at West Stow."

Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lecture.) Dr. Coupland, "Anæmia." (Lecture II.)

British Horological Institute, Northampton-square, E.C., 8 p.m. Mr. Curzon, "The Lever Escapement—its correct Principles and common Faults."

Thursday, March 17th...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Dr. George Watt, "The Indian Species of *Primula*." 2. Rev. R. Boog Watson, "Mollusca of *Challenger*, Part IX." 3. Mr. B. Daydon Jackson, "Note on *Hibiscus palustris*, Linn., and Certain Allied Species."

Chemical, Burlington-house, W., 8 p.m. 1. Mr. F. D. Brown, "The Volumes of Mixed Liquids." 2. Mr. F. Jones, "Boron Hydride." 3. Mr. F. R. Jupp and Mr. Edgar Wilcock, "The Action of Aldehydes on Phenanthraquinone in Presence of Ammonia." 4. Mr. F. R. Jupp and Mr. H. J. N. Miller, "The Action of Benzoic Acid on Napthaquinone." 5. Mr. R. Warington, "The Alleged Formation of Nitrous Acid During the Evaporation of Water." 6. Prof. Hartley, "The Absorption of Solar Rays by Atmospheric Ozone and on the Blue Tint of the Atmosphere." 7. Mr. C. R. A. Wright and Mr. E. H. Rennie, "Note on the Sweet Principle of Smilax Glycyphylla."

London Institution, Finsbury-circus, E.C., 7 p.m. Dr. W. H. Stone, "The Combination of Voices with Instruments" (with illustrations).

Royal Institution, Albemarle-street, W., 9 p.m. Mr. H. H. Statham, "Ornament Historically and Critically Considered." (Lecture I.)

Royal Historical, 11, Chandos-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. R. E. Middleton, "House Drainage and Sewerage."

Royal National Lifeboat Institution, 3 p.m. Annual Meeting at Willis's Rooms, St. James's.

Friday, March 18th....Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Gulstonian Lecture.) Dr. Coupland, "Anæmia. (Lecture III.)

Royal United Service Institution, Whitehall-yard, 8½ p.m. Captain C. W. B. Bell, "The Cavalry; its Reconnoitring, Screening, and Outpost Duties."

Royal Institution, Albemarle-street, W., 9 p.m. Dr. W. H. Stone, "Musical Pitch and its Determination."

Philological, University College, W.C., 8 p.m. Mr. J. P. Postgate, "Latin and Greek Derivations."

Saturday, March 19th...Ladies' Sanitary Association (at the House of the Society of Arts), 5½ p.m. Dr. B. W. Richardson, "Domestic Sanitation or Health at Home." (Lecture V.)

Royal Institution, Albemarle-street, W., 3 p.m. Rev. H. R. Haweis, "American Humorists." (Lecture I.)

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FRIDAY, MARCH 18, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The second lecture of the third course was delivered on Monday, 14th inst., by Professor W. G. Adams, F.R.S., on "The Scientific Principles Involved in Electric Lighting." The subjects specially dealt with in the lecture were the measurement of electric currents, the efficiency of magneto- and dynamo-electric machines, and the heating effects of the current. These were illustrated by a series of experiments. The lectures will be published during the summer vacation.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1881, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially, by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1873, to C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts ; and for his improvement in the manufacture of iron ; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy, and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious manual labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal services rendered to Arts, Manufactures, and Commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

The Council invite members of the Society to forward to the Secretary, on or before the 23rd of April, the names of such men of high distinction as they may think worthy of this honour.

LABEL FOR PLANTS.

The Council are prepared to award a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary not later than the 1st May, 1881.

The Council reserve to themselves the right of withholding the Medal and Prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

PROCEEDINGS OF THE SOCIETY.

FOREIGN AND COLONIAL SECTION.

Tuesday, March 15th, 1881; Harry Escombe, Member of the Legislative Council of Natal, in the chair.

The paper read was on—

DIAMOND FIELDS OF SOUTH AFRICA.

By R. W. Murray.

Seeing how little is known of South Africa, its people, and natural resources here in England, and how much this country, as well as its rich and vast colonial dependency, has lost, and is still losing, through the lack of such knowledge, it becomes the duty of every man who is informed upon South Africa, its public affairs, its soil, climate, resources, and people, to impart all the information upon these that he can whenever a suitable opportunity presents itself.

Few men who have made themselves thoroughly acquainted with South Africa, whatever opinions they held before visiting it, but are convinced that it is destined to become a great country—English colonists hope, a most important portion of the British Empire.

It is not long since you heard from Sir Bartle Frere, in this very room, how rich and varied are the industrial resources of South Africa. That gifted lecturer has, since his return to England, devoted himself most arduously to his self-imposed task of making South Africa better known to his fellow-countrymen, and to him the people of South Africa will feel more than ever attached, if that be possible, when they come to see how much he has done for them upon English platforms.

I am not about to lecture on the general characteristics of South Africa, but to bring, as far as I can, into the prominent notice it deserves to have, that part of the South African continent in which I have spent the last ten of the twenty-seven years I have been in the country.

Whilst very little is known in England of any portion of South Africa, the Diamond Fields are the least known, and have, I think, been most misrepresented, and yet no single spot of ground in the whole world is better worth knowing than they are. I have held, and still hold, that no discovery of modern times is more remarkable than that of the Diamond Fields of South Africa; no portion of her Majesty's dominions has made such rapid progress in civilisation and wealth, and unless the progress of the province of Griqualand West, in which the Diamond Fields are situated, is checked by misgovernment, it will be one of the chief centres, if not the chief centre, of trade and commerce in that great country.

I shall not weary you with any speculation or theories regarding the formation of the diamond, or take up any of the time allotted to me, by introducing any of the questions regarding the geological formations of this territory, which has, from time to time, been discussed in the scientific world. I shall but a plain, unvarnished tale deliver of its history, from the time of its discovery to the present hour, endeavouring to show you how vastly it has contributed to the wealth of the world, how much it is still contributing, in what an extraordinary manner it has been the means of civilising the native tribes of the country, and the important part it has played in the history of South Africa during the last ten years.

In the first place, as to the discovery of the Diamond Fields, it is necessary to mention that, in 1867, the Cape Colony and Natal were suffering most acutely from financial and commercial depression. The Free State had had several years of fighting against its native neighbours, the Basutos, and its indebtedness to the Cape Colony and Natal had hardly come to be considered to be of any worth to colonial creditors, and a general bankruptcy throughout South Africa appeared inevitable.

The public works which had been projected by the Cape Parliament had been stopped one after the other; the engineers and navvies, brought out from England for railway construction, were, most of them, out of employ. The stores of the merchants in Cape Town, Port Elizabeth, Grahamstown, and the other principal towns and centres of trade, as well as those of Natal, were glutted with stocks, which were not to be moved off. The life of South Africa appeared to have gone out of it. The farmers had raised money on their estates, until, one after the other, men, once well-to-do, went into the *Gazette*; and so bad was the state of affairs in the western province of the Cape Colony, that many a man who had been a producer of cereals all his life, had to go and beg meal for his family use.

The chief cause of this dire distress arose from the long series of droughts to which the country had been subjected. So bad was the state of things, and so helpless had everything become, that many families, who could command money enough to pay their passages, left the country for other shores.

In the course of that year, 1867, just as things were at the very worst, and men had come to regard the whole of South Africa as God-forsaken,

Mr. John O'Reilly, a trader and hunter in the interior, was in Albania. Here I had better explain that Albania is a portion of the province of Griqualand West. It was a portion of the territory of the Griquas, who were under the chieftainship of Nicholas Waterboer, who afterwards ceded his territory to the British authorities. That territory, which became a Crown colony, and in which are the diamond diggings and mines, is situated between the Cape Colony, the Free State, the Batlapin territory, and that which is set down in the old maps as occupied by Hottentot tribes, and in which the copper mines are found. I shall endeavour to avoid embarrassing you with more of such details than are unavoidable. The latitude and longitude are not at all essential to the subject with which I am dealing. It will be sufficient for you if I state that Griqualand West is about 600 miles from each of the sea ports, and that it is approached by various routes; those most frequented are the western, or Table Bay route, the eastern, from Port Elizabeth, the frontier, or the East London route, and the Durban or Natal route.

Albania, of which I commenced to speak, was a portion of the Griqua territory, settled by colonists, under terms made with Waterboer, some two years before the discovery of diamonds had been heard of. One of the colonists who had helped to form the settlement was a Mr. Van Niekirk. Mr. O'Reilly, who was returning from the interior to Colesberg, called upon Van Niekirk, and remained with him the night. In the course of the evening, one of Van Niekirk's children, a little girl, was playing on the floor with some of the pretty pebbles which are common in the neighbourhood of the Vaal River. Mr. O'Reilly's attention was directed to one of the stones, which threw out a very strong light, to which Mr. O'Reilly's eyes had been unaccustomed. He took it up from the floor and offered to buy it, asking what Van Niekirk would take for it. The simple-minded Boer could not be made to understand what the meaning of purchasing a stone could be, and he said he would take no money for it, but that if Mr. O'Reilly had a mind to it, he could have it.

The colonial trader is generally represented as a verneuker of a most designing and unscrupulous kind, but there are men amongst them whose right dealing and high character would stand comparison with those of any men in the world, and no men have a better footing amongst the Boers than the old-established traders. Mr. O'Reilly is one of them. He told Van Niekirk that he believed it to be a precious stone, and of value; he would, therefore, not take it for nothing. It was ultimately agreed between them that O'Reilly should take the stone, ascertain its value, and, if found to be a diamond, as O'Reilly suspected it was, that it should be sold, and the money divided between them. Mr. O'Reilly took the stone to Colesberg, where he showed it, and he confidently stated to the people he met at the bar of the hotel that it was a diamond. He wrote his initials on the window-pane and cut a tumbler with the stone, and was laughed at for his alleged foolishness, as many a discoverer had been before him. One of the company took the stone out of O'Reilly's hands and threw it into the street. It was a narrow chance that the stone was found again, and, had it not been, it is quite a question whether the Diamond Fields of South Africa had yet or ever been discovered in our day. However, the stone was found, and O'Reilly sent it to Grahamstown, to Dr. Atherstone, to be tested, and the doctor and Bishop Ricards, the Roman Catholic Bishop of Grahamstown (one of the most scientific men in South Africa) both pronounced it to be a diamond of $22\frac{1}{2}$ carats. From Grahamstown the stone was sent to the then Colonial Secretary, the Hon. Richard Southey, afterwards the Lieutenant-Governor of Griqualand West, who submitted the stone to the best authorities at hand, and they all decided it to be a diamond. It was then forwarded to the Queen's jewellers, Messrs. Hunt and Roskell, who confirmed the decisions obtained in the colony, and valued the stone at £500. At this valuation, it was purchased by his Excellency, Sir Philip Wodehouse, who was Governor of the colony at the time. Mr. O'Reilly, as soon as he had ascertained for certain that his first stone was a diamond, set out to see if he could not find others, and was not long before he found one of 8 carats and $\frac{7}{8}$, and this too was purchased by Sir Philip Wodehouse for £200. This led to a good deal of excitement throughout the country. Small diamonds were brought in by natives. Then flashed the startling intelligence through the country, that a diamond of over 83 carats had been discovered. This turned out to be true, and this is how it came about. Mr. Van Niekirk, from whom Mr. O'Reilly obtained the first stone, hearing that it had turned out to be a diamond, remembered that he had seen one of a similar character in the possession of a native, and set out to find it. A Boer is not long in getting hold of a native when he wants him, and Van Niekirk soon had his man. The native had kept the stone, and Van Niekirk gave him nearly all he possessed for it—about 500 sheep, horses, &c.—but at whatever the price, he obtained the stone, and set off with it to Messrs. Lilienfield Brothers, of Hopetown, merchants of long standing in South Africa, and now represented in Hatton-garden. They purchased the stone for £11,200, and christened it "The Star of South Africa," forwarded it to England, and it ultimately became the property of the Countess of Dudley, who purchased it of Messrs. Hunt and Roskell.

That all this would have a great effect upon communities, whatever their conditions and prospects in life, no one will have the least difficulty in believing, but the excitement it did create amongst the various communities of South Africa, who were at that period on the verge of bankruptcy, it would be difficult to convey to you. It is said that drowning men catch at straws, and I have no doubt that that proverb is well founded. But it is one thing for a drowning man to catch at a straw in his last extremity, and another for him to be inspired by faith to rise and walk upon the water. The people, who almost despaired of the country or themselves being restored to prosperity again, wanted to see the prints of the diamonds on the hill-sides from which they had been taken. They did not deny that the diamonds had come to Cape Town, nor that they had been sent to England, nor that they had been sold for much money. Some had seen the diamonds, others had seen men who had seen them, and, besides, Sir Philip Wodehouse had purchased two and paid his money for them, and the word of Sir Philip Wodehouse was at that time a

law unto all South Africa. Where did the diamonds originally come from? That was what they wished to know. They were out of love with the Cape, and it was with the old colony as it was with Nazareth, men shook their heads and asked each other "Can any good come out of it."

They at first, of course, denied that there were any diamonds. Then, when they could do that no longer, they said that they had not been found in South Africa. At last, they not only thought, but said, that the whole thing was a plot of the Hope Town and Colesberg owners of land to send up the price of their land, and that they had imported the diamonds from the Brazils. What wonder that this should be said, when an authority on such matters, who was sent out by one of the first dealers in precious stones in the known world to spy out the land, after making a tour through it, and a scientific survey of it, reported most dogmatically that there could be no diamonds found in the country, and gave his "reasons why." A letter appeared in one of the leading journals, duly signed by this great authority in diamonds, in which the writer settled, to the satisfaction of those who previously doubted the validity of the diamond finds, that South Africa was non-diamondiferous.

What do we not get settled for us by authorities in the leading journals? Alas! for some of the authorities, the result of their settling affairs of politics, sciences, and art is much the same as in the case in point. Whilst the print was fresh which conveyed the decision to the world that no diamonds could ever be found in South Africa, intelligence arrived in England that good parcels of diamonds had been secured by several well-known persons.

At the end of 1868, the more enterprising of the colonists pushed their way up to the Vaal River, where it was supposed the diamonds had been found. There has always been much discussion as to who were the first in the field. I have taken pains to discover, and I think there can be no doubt that the first party who went up from the colony to search for diamonds was formed in Bethulie, headed by the late Mayor of Kimberley, Mr. J. B. Robinson, and that the next came from Natal, the men of which colony have always been famed for their enterprising character. It was not, however, until about Christmas, 1869, that the general movement commenced, and, at that time, a party from King Williamstown (British Kaffraria) passed through the Free State. They made no secret as to their destination or purpose, and were thoroughly ridiculed when they said they were going to search for diamonds along the banks of the Vaal River. When the Bethulie party first arrived, they had no idea of digging for diamonds; they considered, like many other people, that diamonds fell "like the gentle dew from heaven upon the earth beneath."

When they arrived, they found on the banks of the Vaal, half-way between the Berlin Missionary Station and a place called Hebron, where the first diggings were established, a native who had a diamond in his possession. He had heard that it might be a diamond, and he had wrapped it up in several dirty bits of rag, and tied it up, but he never suspected that he was to get eight golden sovereigns for it as he did. Of course, the rumour that such stones were worth so many sovereigns soon got noised abroad, for the first thing the native who had all this money did, was to give a jollification to his sisters, and his cousins, his uncles, and his aunts, and the jollification lasting over some ten days, brought together natives (chiefly Koranas) from far and near. The natives were set looking for diamonds along the ridges of the hills, and they found well. Some fourteen hundred were soon at this work, and the Bethulie party sent into the colony, realised their property, and brought Basutos up to work expressly for them. The party settled on a farm there, called Livingstonia, near Hebron.

No thought of digging for diamonds appears to have occurred to any one until the arrival of the party from Natal, one of whom had been a gold-digger in California and Australia. His idea was to sink a shaft; that, however, was a failure, and the digging out of the diamondiferous soil, and cradling it for diamonds, just as in gold-seeking, was adopted, and the principle of which obtains to this day.

Whilst the parties I have mentioned were operating on the banks of the Vaal near Hebron, the Kaffrarian party crossed the Vaal lower down and settled themselves at a place called Klipdrift, where they picked up diamonds too. They, hearing that there was a party up the river finding well, went up there, and, by the time they had reached Hebron, they found that other parties had come from Natal, and others were on their road. In a month or two after, there were hundreds upon hundreds of wagons loaded with diamond-seekers, on their way from all parts of South Africa, bound for the Vaal River. At the first, all the diamonds were found on the side of the river furthest from the Cape Colony. About the middle of 1870, a large number of wagons of colonial Boers and colonists arrived at Pniel, which is the name of a hill on the colonial side of the river, and the Boers and colonists to whom the wagons belonged, discovering that the river was "down"—which means that it was too deep to be crossed—outspanned there, and, as the river remained unfordable for over a fortnight, some of the Boers and others thought they would dig, and see if there were no diamonds to be found on that side of the river as well as on the other. They did so, and were soon rewarded with diamonds, which they—at the time, not knowing anything about cradling—picked out of the soil which they dug up. But for the Vaal River having been unfordable, the Pniel diggings might never have been discovered. The majority of those who had outspanned at Pniel never crossed the river to Klipdrift to dig, but remained where they were, and a camp was formed there. This was the origin of the famous Pniel Diggings, out of which hundreds and hundreds of men made fortunes. Klipdrift was at the time considered no man's land; the chief, Jantje a Koranna, was supposed to have the most right to it, and he himself always told the diggers that that territory belonged to him, and he took a good deal of money for farms from the diggers which, of course, they never got. On the Klipdrift side no money was paid for the right to dig. Pniel was and is the property of the Berlin Missionaries, held under a grant from the Free State Government. Ten shillings a month was paid for digging there, and that money, when diggers paid it, the Berlin Missionaries received,

either wholly or in part—I am not sure which. By September, 1870, the Pniel camp had become a town—a canvas town, as a matter of course, and on the Klipdrift side a canvas town had also sprung up. In 1870, there could not have been less than 500 cradles at work on the Pniel side of the river, and 250 on the Klipdrift side; Hebron was as busy.

A great many diamonds were found, but it is a question whether, up to September, 1870, the Diamond Fields gave a profit on the outlay expended on them. A good many men had made large sums of money out of the diamonds they found, for the price then paid was greatly in excess of that which diamonds now realise. I shall go on to give an outline history of the diamond diggings, and show how they sprung into existence, before I touch the land disputes which arose. As the diggers crowded in, and elbowed each other in their eagerness to get claims, the necessity for some sort of government was felt. The first effort to enforce law and order was made by the diggers themselves. Diggers' protection societies were formed, and committees were appointed. On the Klipdrift side, the committee not only dealt with the differences between the diggers, but it also administered justice; and I, looking back over the difficulties of the situation, and remembering how large a proportion of the community was made up of men who had for a long time been wandering about the country looking for employment, and not finding it, I am bound to say that, on the whole, justice as substantial as is to be had in our English courts was administered there, and order was fairly well maintained. This must be attributed to the fact that there were, on the Klipdrift side, a very large number of men who had been accustomed to public life in England and in the Colonies. They kept the turbulent spirits in check, and punished offences against law and order with a firm hand. The Klipdrift committee was composed of Englishmen—that is to say, of English-speaking men. They had either come into the colony from England, or they were the descendants of English parents who had settled in the Cape Colony or Natal. The members of that committee had resolved amongst themselves that their side of the river should remain English. There were some Boers amongst the crowd, but they were as desirous that British rule should be introduced as were their English neighbours. This is most generally the case when the intelligent Colonial Boer is not under the influence of Africander or other agitators.

The Free State had sent down a magistrate from Bloemfontein to administer justice in that camp. The Transvaal Government had sent down a magistrate to Hebron. The latter Government, with a keen eye for territory, appointed a gentleman to sit as magistrate at Klipdrift, but the Klipdrift diggers made him understand that the Transvaal Government had not, and never would have, any control over that place. The men of Klipdrift, who led the way in most things, quietly conducted the Transvaal nominee to a boat, and put him across the river, leaving him on the Pniel side. This was at the time their mode of dealing with men who were not wanted. By October, 1880, the camps were swarming with population. New rushes were reported along the river, and as soon as any new rush was discovered, many of the diggers, who had been doing well before, left their claims and went off to the new places. Men who take to gold or diamond digging are never the sort of men to let well alone. They start on their enterprise with the idea that they are to get rich quickly, and their riches never come fast enough to hand. The *bonâ-fide* rushes down the river yielded, in some cases, more diamonds per individual digger than did Pniel, Klipdrift, or Hebron, and there were amongst those who operated at each place men who, from being next to penniless, soon became well off.

It was at one of these minor diggings down the river—not, however, discovered until 1872—that Mr. Spalding's diamond of $288\frac{1}{2}$ carats was found. Although this diamond was $205\frac{1}{2}$ carats heavier than the "Star of South Africa," it did not bring to the finder much more than half the amount of money paid by Mr. Lilienveldt for the "Star" which created the first excitement.

The men who came to sell and not to dig, seeing how eager the diggers were to get to new rushes, very soon commenced to turn that weakness to account. The schemers, who had on hand large stocks of wines and spirits sent from the colony, selected spots at some distance from the old-established diggings, and commenced digging, they themselves whispering to others that they had "found" there, and sometimes would show some fine stones which they said they had taken out at a foot or two deep. As soon as this was known, there would be a rush of diggers from the old spots to the new one, and every digger would mark out a claim for himself. Whilst this was doing, a canteen would be started, and, as men cannot dig long in a climate where it is frequently 110° in the shade, the canteen man drove a lucrative business. For some time this game answered very well. There would, as a rule, be a hundred or two diggers assembled at the new rush, all bent upon digging, and they would go on digging for a week or a fortnight before they found that the new rush was of no account, by which time the canteen keeper would have sold off all the stock he had originally of his own, and, in many cases all he could buy up in addition thereto. When the patience of the diggers was exhausted, so would his stock be; and he would then lower his tent, and go back with the diggers, deploring that the new rush had not answered. I need hardly tell you that the canteen-keeper was either the discoverer of this "rush," or an agent of his was. After a time, but not for a long time, the canteen rushes ceased to draw. Those who stuck to their claims in the first established diggings did best for themselves, as a rule, and the men who traded fairly with the steady-going digger did best in the long run.

At one time it was thought that there would be a difficulty in getting provisions and supplies, but the stock-breeder, and the butcher, and the baker, and the store-keeper, soon followed upon the grand army of diggers, and shops, supplied from the stores of the merchants in the Cape Colony and Natal, increased and multiplied as fast as the population. There never was any want of food or digging appliances at any time, although the fare was hard and coarse, and such as few of those I am now addressing would be inclined to put up

with for any amount of money. The stocks which had for several years laid heavily on the hands of the colonial merchants in the port towns, found a ready market, and the depression which, before the discovery of diamonds, had driven half the merchants in the Colonies to distress, desperation, and, in some cases, to bankruptcy, gave place to cheerfulness and enterprise, and trade in South Africa became brisk. The spirit of enterprise was quickened. The merchant increased his importations from England. The English manufacturers of picks, shovels, wheelbarrows, and corrugated iron, soon shared in the advantage of the new discovery, and the Customs returns of the Cape Colony, which had fallen very low, showed such a marked increase as they had never done before in so short a time. To give you an idea of the marked effect which the discovery of the Diamond Fields had upon trade and customs, I may remark here that the import duties which, in 1869 (the year in which diamond digging was first started), were but £1,953,091, had risen by the end of 1871 to £2,585,298; whilst at the end of 1879 they had risen to £7,080,229. With this aspect of Diamond Field history, I purpose to deal later on.

It was a remarkable feature of the Diamond Fields, in the first period of their history, that such crowds of men should have worked side by side with so little outrage. Crime of a serious kind was seldom committed. There was none of the outbreaks which in California, in the early days of digging for gold there, called the Vigilantes into existence. In that country it became necessary, for the sake of life and property, to keep a body of men with loaded revolvers in their belts—a stern necessity—and bands of ruffians were shot down without mercy. On the Australian gold-fields, blood-shedding had to be resorted to, and in the history of gold-digging in that country, occur records of brutality little less horrible than in the historical records of California.

The Californian diggings, in their earliest days, were the resort of the off-scourings of America and elsewhere. The great mass of the men who crowded the banks of the Vaal — indeed, I may say nearly all who first arrived there to dig for diamonds—were colonists, the most of whom had occupied positions in which character was indispensable. A very large proportion of the diggers of 1870, who operated on the banks of the Vaal River, were colonial born men from the frontier districts of Natal, either men who left their farms, or their businesses, or professions in the frontier towns. Those who formed these parties were most usually related to each other in some way—either by blood or business. Then a good many military men, who happened to be in the country at the time, obtained leave of absence, and joined in the rush. The first persons who came into the fields from Natal were Messrs. Glennie and King. They joined the Bethulie party, headed by Mr. Robinson, of the firm of Robinson and Marcus, of London and Kimberley, who opened up the diggings on Livingstonia (afterwards Robinson) and Hebron. Glennie had been a gold-digger in California and Australia, and he first introduced digging and cradling. Up to the end of 1870, very few persons had come from other countries to dig for diamonds.

In South Africa, as in all other parts of the world, there are men who never work until they are compelled, and who are incorrigible and irrestrainable. There are far fewer of these men in South Africa than in any other country I have yet seen, but still, they are even too plentiful in South Africa. They cannot live long in idleness and debauchery in the towns, hence they make their way to the farms, and obtain a living amongst the Boers. At the port towns the worst of them are found; but there are not a great many port towns in South Africa, and the Diamond Fields are too far from the ports to be easily reached by such men as those I speak of. However, by about October, 1870, from the ports and the farms there came, amongst the thousands who were swarming the banks of Vaal River, a hundred or two of the restless, rowdy, worthless men, who never care for any settled employment. But these never had the least chance of getting the upper hand at any of the camps. The moral force of the bulk of the diggers was sufficient to silence the idle and unruly whenever they became restless. The Diamond Fields, however, had not been long in existence before parties sprung up. It was curious to see how men became ambitious for place and power in that outlying region, just as they do in England, America, France, and elsewhere; and it was in the contentions and conflicts of such people that the unruly element became dangerous. They were always ready to back anyone who would pay or stand drinks, and would as soon shout for a Transvaal magistrate as an English, for a president as for a diggers' protection association. It was all one to them—they only cared for who paid best, or who would "stand Sam" the more readily. At Pneil and Hebron, the Englishman and the Dutch Boer worked side by side without any consideration of nationality. In five cases out of ten, the Englishman did not understand one word of Africander Dutch, nor the Boer a single word of English, so that if they did quarrel, it could not be a "word and a blow." Whilst, however, individuals worked along together pleasantly enough without regard to nationality, there was a good deal of feeling arising out of the different nationalities which governed the several camps. For instance, Pneil was under the flag of the Orange River Free State. Hebron was under the flag of the Transvaal Republic, and Klipdrift under no flag whatever, but the English flag was understood to be the Klipdrift flag. The Transvaal would have liked to have taken possession of Klipdrift, and did try. The Dutch element at Pniel were equally eager with the Transvaalers to get possession, and both did attempt it. The Transvaal Government, as I mentioned before, did send a magistrate, but he was put across the river. The magistrate at Hebron put an Englishman into prison because he refused to pay a 10s. license to dig, and the Klipdrift men, that is the men on that side of the river, armed themselves, and went up and forced the magistrate to liberate his prisoner, and made his worship entertain the liberation army into the bargain.

It no doubt kept the republican element under, when it became known that the subjects of her Majesty in the Fields had memorialised. Lieutenant-Governor Hay, then acting as High Commissioner and Governor of the Cape Colony, to assert the Queen's authority on the banks of the Vaal, and that his Excellency had sent back a favourable

answer. In those days the power of England was supreme, wherever it dared assert itself, in South Africa, and the word of whoever represented the Crown was as law to men of all nationalities and races.

When I said that there was a desire amongst the Dutch element on the Pniel side to have possession of Klipdrift, I must be understood not to mean that the President of the Free State, representing that State, had any such design. On the contrary, in a conversation I had with him at the Presidency, in Bloemfontein, in about August, 1870, he distinctly told me that the Free State had no claim whatever upon the land on the Klipdrift side of the river, but the Dutch Boers, I mean the majority of those one meets with in that territory, so far removed from the sea, look upon themselves as the rightful owners of all lands they can come across, which are only occupied by natives. The British Government, as I presume you are aware, did make, at the close of 1870, some sign that it intended to protect its subjects who were operating in thousands along the banks of the Vaal. The chief Waterboer had solicited the representative of the Crown, years before that time, to take him and his people under its protection. It has been said, and very many times repeated, that the British Government would never have cared whether the Free State or Waterboer took the land in dispute between them, but for the discovery of diamonds in the disputed territory. Nothing can be further from the truth than is this, as reference to Blue-books and other documents will prove. Years before the discovery of diamonds, Sir Philip Wodehouse, whilst High Commissioner and Governor, had taken action in this matter, in consequence of the encroachments of the Boers upon Griqua territory. Waterboer had tendered his country to the Government, also years before, and his people had long been anxious to be under the Government of the Queen. In 1870, when the memorial was sent to Lieut.-Governor Hay, then Acting High Commissioner and Governor, to take the Diamond Fields under his protection, Waterboer was quite as anxious as the memorialists that the British Government should do so. But neither the Colonial Government nor the High Commissioner had any power to hoist the British flag over new territory, and much time was lost before anything whatever was done in the matter. At last, however, it was decided to send up a special magistrate, appointed by the High Commissioner, to administer law and justice under the authority of a Griqua chief.

I have now given you an outline history of the origin of the Fields, and of what I consider to be a distinct phase in their history. I shall endeavour to lead up, stage by stage, until I reach the present period, when art and industries have obtained permanent and secure footing there.

I regard the arrival of the special magistrate in the Diamond Fields as the commencement of a new era in their history. His arrival was hailed by Englishmen on both sides of the river with unqualified satisfaction.

It was a novel sight to see an English magistrate holding an appointment under the combined authority of the Crown of England and a native chief. However, I suppose it was the best thing that could have been done under the circumstances. Had he not arrived when he did, there can be no question that the Free State Boers would have come in and possessed themselves of all the land where the dry diggings now are, for, after the arrival of Mr. Campbell, an attempt was made to compel the diggers working at the smaller diggings down the Pniel side of the Vaal River to pay tribute to the Free State. An armed force did come into Pniel, and threatened to force diggers at Cawood's Hope, and such like places, to pay taxes to them, but the English diggers defied them, and the armed Boers seeing the attitude of the diggers thought it best not to attempt force.

I now propose to pass from the river diggings to the dry diggings. There had been, for some time before Mr. Campbell's arrival, talk about diamonds having been found at Du Toit's Pan, and Bultfontein—two farms, 24 miles from the Vaal, on the road to the Orange River Free State. The most wonderful portion of the Diamond Fields is that of the dry diggings. They derived this name from the fact that there was no water there, and the diamonds having been originally discovered in a light sandy soil, it was thought that they could be found without the diggers having to undergo the laborious operations of cradling and washing the soil before sorting, which they had been compelled to do whilst operating on the banks of the river. The first of of the dry diggings to attract public attention was Du Toit's Pan, to which a few diggers had resorted before the close of 1870. Small diamonds had been found on this farm, and on the adjoining one. Du Toit's Pan belonged to a Mr. Van Wyk, and Bultfontein to a Mr. Du Plooy. It is scarcely worth while to wade through the details of purchase and sale, and the disputes and actions at law, which came out of the purchase. It will be sufficient to state that these two farms ultimately became the property of the London and South African Exploration Company, and were, when first purchased by that company, under the jurisdiction of the Free State. The work here was found to be a good deal easier than it was down the river, no water being used. The big boulders which had to be dug out to get at the diamondiferous soil at Pniel and Klipdrift did not stand in the way of working here. The ground was all soft, and of a consistency which could easily be worked with a pick and shovel. There was no breaking up of the ground after it had been dug out. All the operation necessary to get it on the sorting table, was to sift it in a sieve with a large mesh in the first place, to get rid of the large stones, and afterwards to sift it in a fine sieve, which was usually made in the shape of a hand barrow, and swung to and fro by the men holding the handles, or fastened by reims at either end to upright posts, and worked just as is a swinging cot. The process of getting through the work was very light and simple. The early diggers on the dry diggings, dug pits of about two or three or four feet deep, threw the stuff into a coarse sieve, and then placed it on a sorting table, to get rid of the large stones, then took the coarse sifted gravel, and sifted it in a very fine sieve, where the sorter, with a piece of zinc, scraped it across the table, and picked out whatever diamonds

there were to be found in it. Reports of good finds continued to appear in the columns of newspapers which were then published at Pniel and Klipdrift, and as these reports increased in frequency, so did the population in bulk. Klipdrift had long before been abandoned as diggings. It was a town of shopkeepers and tradesmen, and was fed from the down-river diggings, such as Cawood's Hope, Forlorn Hope, Union Jacket, and other diggings of that sort. Pniel was in all its glory in the early part of 1871, when there was a rush off to Du Toit's Pan. The chief part of the time of the special magistrate at Klipdrift, during the first six months he was there, was taken up with the settlement of disputes about land which existed between the Transvaal Government and the native chiefs. The Free State magistrate had become a sort of king on his side of the river, and now, when the rush was taking place from all parts of the river to Du Toit's Pan, he took care to open a second court there; and, in a very short space of time, Du Toit's Pan became an immense camp. Very large and good diamonds were found there. The proprietors of Bultfontein did all in their power to prevent that estate being rushed, but they could not withstand the will of the diggers, who jumped the place. The proprietors appealed to the Government of the Free State, but the Free State Government had no more power than the proprietors themselves to restrain large bodies of men. The best thing that could be done was done to make terms with them. Mr. Van Wyk's friends, who first worked at Du Toit's Pan, gave him one-fourth of their finds for giving them the right to work there, but when the diggers came up from the river, they were not satisfied with this arrangement, and a monthly license to dig became the settled thing. At first, the cost of the license was 7s. 6d., but was afterwards increased to 10s. By the middle of 1871, Du Toit's Pan had become a town, with hotels, stores, and shops; and then, it having been noised abroad that diamonds could be had for the picking in the South African Diamond Fields, the excitement was no longer confined to South Africa—men came from England, America, and Australia. The roads from Cape Town and Port Elizabeth to the diamond fields were full of life—vehicles of all sorts ran between the fields and the colony. A rude kind of omnibus, drawn by mules, was the first attempt made to convey passengers to and fro. For some time in 1870 and 1871 this and the post-cart were the only public vehicles by which the fields could be reached. Afterwards, transport companies sprung up, and the journey of from six to seven hundred miles was made in about eight days, and with a fair amount of comfort.

The adjoining estate to Bultfontein and Du Toit's Pan, Vooruitzigt, was the property of Mr. de Beer. He and his sons had been working Vooruitzigt as a farm, but they, seeing the success of the Du Toit's Pan and Bultfontein diggers, and that their farm partook of the same character, commenced digging at old De Beers for diamonds also. They found a few; this brought other diggers to the spot, and then they resolved to open diggings, which they did on the same terms as their neighbours at Du Toit's Pan and Bultfontein. They laid out a town and offered erven, or sites for building, at auction, on the 21st of October of that year. Nearly up to the time when these diggings were opened, there had been great suffering from want of water. One gentleman, residing at the "Du Toit's Pan" hotel, after being there for two months without being able to get water enough for a bath, determined to have a bath of soda water, and ordered the landlord to send him as many dozen of sodas as would be sufficient. This the landlord refused to do, as he had got the soda with some difficulty, in order to sell it with brandy to customers. "Then," said the customer, who wanted the bath, "send me the brandy with the sodas, that I may have my soda's and b's." This the landord did, and the gentleman told his friends that he drank the brandy and bathed in the soda water.

At old De Beers, water was found at a much lesser depth than at Du Toit's Pan, and this, added to the picturesque appearance of the camp, made it the most attractive, especially to diggers who had brought their families with them. Indeed, De Beer's afterwards became the Belgravia of the Fields; it was the residence of the Lieut.-Governor during the time the fields were really governed as they should be; and, of course, the residence of the Lieut.-Governor was, as it ought to be, the centre, around which society gathered, fluttered, and plumed its wings.

In July, 1871, came the crowning of the diamond discoveries in South Africa. Early in the month of that July a new rush had been reported at about a mile beyond De Beers, and many diamonds were found near the surface. It was only a small "kopje," or hill, a few acres in area, surrounded by a reef of hard rock. The claims were marked out by a gentleman, Mr. Finlason, now residing in London, and all taken out on the 10s. monthly license system. There was a rule made by diggers' committees, strictly adhered to by them, and afterwards, when the Fields had been declared British, was as rigidly adhered to by the Government, viz., that no man should hold more than a certain number of claims; two when the claims were first allotted, and, I think, six afterwards by purchase or otherwise. I am not sure of the number, but that was about the limit, and no matter how many claims a man purchased, he could not register more than the fixed number in his own name. The claims given out at the Colesberg Kopje were thought, at about two months after the working of the kopje was commenced, to be the luckiest thing in the world for those to whom they were given. Fine large stones were picked out in abundance, and within three months after the claims had been marked out, they were sub-divided, and quarter claims sold for as much as £500 and £600; whole claims did fetch, in some cases, as high as £2,000; and the prudent people who saw this, remarked how utterly reckless men were when in search of wealth. The De Beers were prudent men. When Mr. Alfred Ebden, of the firm of Dunell, Ebden and Co., merchants, of Port Elizabeth, came up on a visit to the Diamond Fields, and offered the De Beers £6,000 for the Vooruitzigt estate, which included the Colesberg Kopje and old De Beers diggings, and town, with a vast area of land, homestead, and other building besides, they jumped at it, pocketed the money, and thought themselves very fortunate indeed. Before diamonds were found

upon it, I have no doubt they would have taken £600. Mr. Ebden formed a company to work the Vooruitzigt estate as diamond fields, and the returns to that company were magnificent.

Wherever there were diggings, a town of course sprung up round them. As it was at Pniel and Klipdrift, so it was at Du Toit's Pan and Vooruitzigt, and at all the diggings. The last discovered diggings were, for years, known as the Colesberg Kopje, the town surrounding them as "The New Rush." The daily finds at this rush, immediately upon its being worked, were something marvellous, and large fortunes were realised by some diggers, between July and the end of October. I just remember one illustration of the success which attended on the operations, of many. A Mr. Smüts, a Dutchman, bought half a claim for £50, and in two months he had taken out diamonds to the value of from £15,000 to £20,000.

Such returns as these were frequently reported, and the natural consequence was that the river diggings were abandoned for the dry diggings.

Sir Henry Barkly came to South Africa as High Commissioner and Governor of the Cape Colony and Natal, as the successor of Sir Philip Wodehouse, Lieutenant-Governor Hay having filled the acting appointment in the interval between the departure of the one and the arrival of the other. Sir Henry found that, whilst the Diamond Fields were filling the Treasury, that they needed being dealt with promptly and considerately. He, at the very earliest possible moment, came up to see the fields for himself, to meet Waterboer, Pretorius, and the representatives of all interests. He was received with a heartiness he has always been ready to acknowledge. He had been gradually working the machinery for governing the Fields into something like order; but the work was not easy, for the complications were great. His Excellency came to the conclusion that the Diamond Fields should be annexed to the Cape Colony and governed from Capetown; and whilst I, who had resided in the colony then some seventeen years, felt sure that such an arrangement would not answer, I was quite willing to fall in with it, for the sake of having the Fields included in the British Empire. It must be remembered that at the time I am speaking of, the only Diamond Fields we had any command over were those on the Klipdrift side of the Vaal River. Pniel, and all the territory between that and the Free State, was claimed by the Free State Government, and the Free State, in the person of a magistrate, was in possession of Pniel, and all on that side of the water. I do not even now see what better course Sir H. Barkly could have adopted than he did at that time. He recommended the Cape Parliament, after his first visit to annex the Diamond Fields, which they at first led his Excellency to suppose they would do next year. When next year came they declined. Had the leaders of the Parliamentary majority have been as far-seeing as was his Excellency, they would have listened to him then.

The diggings went on yielding, but confusion, from the want of a settled Government, grew worse confounded. Waterboer had always contended that the land on the Pniel side, on which the mines were situated, was his. This the Orange Free State had consistently disputed. As I said before, it was not "diamonds" which originated the dispute. The representatives of the Crown, recognising Waterboer as an ally having claims upon the British and Colonial Governments, had been desirous of putting him in possession, but the office of High Commissioner and Governor of the Cape Colony is not a light one, and the gentlemen who have so ably filled these offices during the last quarter of a century and more, had their hands too full of pressing work to be able to devote the time and attention they would like to have done to this matter of Waterboer's, or he would have been in possession on the day the diamonds were first discovered upon it. However, Sir Henry Barkly brought the matter to a point on the 23rd of October, 1871, by forwarding a document to the President of the Free State, and proclaiming, "Captain Waterboer and his people, British subjects, and the territory in which the dry diggings are situated, British territory." The proclamation made in the Diamond Fields was received with great rejoicings.

Previous to that time, a resident magistrate had been sitting at the New Rush, under British authority, and, strange to say, one had also been sitting under Free State authority at Pniel and Du Toit's Pan. The New Rush is situated between the two, in the same district, and there is but two miles distant between Du Toit's Pan and the New Rush. To get from Du Toit's Pan to Pniel, the Free State magistrate had to pass by the office of the rival functionary, the Britisher, and I know they frequently used to shake hands as they passed each other of a morning, and I have a notion that they as frequently spent a social evening together. The Orange Free State Government saw clearly that it could not control the enormous population which had now gathered round those diggings. The magistrate sent down found that the whole thing had grown beyond his control. When the proclamation was issued, and the British flag was hoisted, I am confident that President Brand and the Members of the Volksraad gave a sigh of relief—I do not mean a sigh between them, but one each, the President the biggest by far. Of course, there was a protest, sent to Sir Henry Barkly. A protest is a South African institution. Nothing is ever done to alter, or amend, or improve, or carry out anything whatever, but some one is sure to send in a protest against it. However, the protest at last brought the Orange Free State £90,000—what for I never understood yet, and I am sure that no one who reads the correspondence which passed between Sir Henry Barkly and President Brand ever will. I am sure Sir Henry Barkly does not. However, I may be allowed to say here, that I consider it worth all the money to have so good a neighbour as President Brand has proved himself to be, close to the Diamond Fields, only that I would prefer him as Lieut.-Governor of the State, to that of President of it.

The dry diggings at last attracted every one away from the Pniel diggings, and, for the most part, the diggers from the lower and minor diggings on the river. Klipdrift, as a town, held out until 1873, the residents all the time contending that the place they had settled, being the first permanent town built, was bound to be the seat of Government, no matter where the population was, or where the productive powers of the

province might be. The foundations of all the British institutions in the country were laid there—magistracies, the High or Supreme Court, and Land Commission, post-office, registry-office, and Government Surveyors' Department. Sir H. Barkly found the Cape Parliament fail him, when he endeavoured to annex the country after he had created the province and proclaimed it British territory, and he paid a second visit to the Fields about two years after.

Between the time of his first and second visit, the Government of the province had been administered by three Commissioners; but the divisions amongst the members of the Commission, and the irrepressible character of the diggers, had, before his Excellency's arrival, led to disaffection and complications; and he had seen, before leaving the Cape Colony, that some change must be made in the plan and principle of government. When he came he found the population so vast, and the magnitude of the enterprise so great, that he saw there was nothing left for him but to convert it into a Crown colony, and give the people a voice in the management of their own affairs. I can give you no better idea of the change which had taken place than to read you a sketch which I wrote at the time in a little work I myself published and dedicated to Sir H. Barkly, and which I have affixed as an appendix to this paper. (See A in appendix.)

Claims in the Du Toit's Pan diggings had been forsaken for what then appeared to be the more profitable claims in the Colesberg Kopje. At a banquet given to his Excellency at Kimberly, he said he had thought that the Fields might have been governed from Cape Town, and he had tried every means so to govern them. He found that they could not be governed from Cape Town, but must have a Legislative Council like that of Natal. He promised that he would bring this about. After this a Lieut.-Governor was appointed. Mr. Richard Southey, one of the most practical, skilful, and single-minded of all those able men who have served her Majesty in South Africa, being appointed to the office. A Legislative Council, under Letters Patent, was created, consisting of eight members—four nominated by the Crown, and four elected by the people, on a franchise that gave to nearly every one a vote, without distinction of race or colour. The Lieutenant-Governor arrived in 1873, and remained in office over three years. It will be easily imagined that it was not easy to govern so mixed a population, in which there were so many conflicting interests, and it will be as easily conceived that men, dissatisfied because they could not get all their own way, could, in conjunction with others bent on creating disturbance, soon breed disaffection. The Lieutenant-Governor was left to do the best he could, without the presence of soldiers or mounted police. An outbreak became inevitable: it took place, and a regiment of soldiers had to be sent up, under General Sir Arthur Cunningham, to show that the British authorities were not to be defied. I shall not enter into the merits of this outbreak, if merits there were. I merely state what were the facts.

During Mr. Southey's administration, the owners of Vooruitzigt, who purchased the estate for £6,000, had been taking from £20,000 to £25,000 per annum, for rents of sites for buildings and shops to be erected upon. The owners of the estate endeavoured to double the rents, and it was seen that it would not do to permit them to have such power over the town in which the seat of Government was fixed, or they would virtually become the Government. The High Court had been removed from Barkly to Kimberley, and the whole machinery of government was centred there. I should have mentioned that, soon after Sir Henry Barkly had initiated British rule in the Diamond Fields, the name of Klipdrift had been changed to Barkly, at the expressed wish of the people there, and New Rush had been changed to Kimberley, in compliment to the Secretary of State for the Colonies, who had held the same office at the time, and the district I had the honour to represent in the Legislative Council was named Hay, in honour of Lieut.-Governor Hay, who was the first to assist in bringing British rule to the Fields. Vooruitzigt was purchased by the local Government, with the sanction of the Earl of Carnarvon, who was then Secretary of State for the Colonies, for £100,000, and those who held sites of land under a month's rental, were called upon to capitalise. This was done, and in this way the Government found itself in a position to pay off the purchase money, and to have the 10s. monthly license for Government purposes. The De Beers Mine is on the Vooruitzigt estate, and was included in the purchase.

I must now travel back somewhat to make you understand how diamond mining in Griqualand West arrived at its present state of prosperity. What I am about to say will be understood now to apply more or less to all the mines, Du Toit's Pan and Bultfontein, as well as Kimberley and De Beers. It is years since those diamond deposits could be characterised as diggings. They are all mines, and those who held claims in the Kimberley and De Beers Mines on monthly licenses are now the owners of the claims, these having capatalised their claims as the standholders did their stands. The other mines belong to the London and Exploration Company, and claims on them are held on monthly license holdings—the company has lately given their claimholders large advantages in return for increased monthly payments for licenses.

Pniel and Klipdrift are no longer places where people go to seek for diamonds. All that remains of the days of diamond digging at Pniel are deep holes, from which men took out the diamonds, and a *debris* of gin cases, sardine boxes, and paper collars. Barkly is still a town, in which one or two firms (one especially, Messrs. Hill and Paddon) are doing a good business with the diggers, who go on finding diamonds of first quality on the banks of the river, some 12 or 14 miles below the town, and an interior trade is also carried on with the firm mentioned.

The process of diamond-seeking has passed through several phases. The original claimholders had their claims for the marking out, and hence they were not called upon to invest capital. They found diamonds in the light, loose, upper soil, and having, for the most part, done well when they got through that soil, sold to others, who went on digging deeper, until they have now to work low at from 300 to 400 feet below the surface. When they found that they

had exhausted the soil in which they had been in the habit of finding diamonds, they came upon a kind of loosely-packed rock, blue in colour, and hard to crumble. They, at first, thought they were ruined, that the diamonds had all been taken out, and that there was nothing left to repay them for working, but on testing this new stratum, it was found to contain more and a better quality of diamonds than the surface soil. Then capital became necessary. The mines were gradually worked down at a depth, for which the diamondiferous soil could be no longer hauled out in ordinary buckets, drawn to the top of the mine by manual labour, and by means of hauling-lines. Steam machinery had to be employed. After arriving at a certain depth, the mines became flooded with water. The Kimberley Mine was first flooded. The water had to be pumped out, which could only be done by the employment of powerful pumps worked by steam. Then it was discovered that there was reef in which there were no diamonds, nothing but hard rock. This had to be taken out. For this purpose steam-engines had to be procured, and tramways made. All this required a great deal of capital, and those who had no capital were compelled to give way to others who had. The general interests of the claimholders, in each diamond mine, are looked after by a Mining Board, elected for that purpose. And the cost of taking out reef and water is borne by the whole body of claimholders.

I have here a rough diagram, showing how the Kimberley Mine is laid out, and how it is assessed. This I will explain to you.

The diagram here shown is of the Kimberley Mine, and it is a plan upon which that mine is laid out. This plan applies to all the mines. The Kimberley Mine is eliptical in form, and its area is estimated roughly at about seven acres. The squares you see marked out show the claims, and the figures the estimated value of each claim for rating purposes. There are—

25	claims	valued at	£7,000
80	,,	,,	6,000
43	,,	,,	5,000
29	,,	,,	4,500
32	,,	,,	4,000
48	,,	,,	3,500
35	,,	,,	3,200
14	,,	,,	3,000
13	,,	,,	2,500
11	,,	,,	2,000
8	,,	,,	1,000
1	,,	,,	600
2	,,	,,	500
1	,,	,,	400
2	,,	,,	300
2	,,	,,	250
1	,,	,,	200
14	,,	,,	100
19	,,	,,	50

This assessment is far below the selling price—on an average 25 per cent. below. The £7,000 claims would fetch £10,000 in the market, the £6,000 about £8,000, and so on. This was the valuation of last year. In about a month there will be a new valuation, and then it will be found that the values will be much increased. The depth of the mine averages from 300 to 400 feet. This mine is nearly, if not altogether, worked by companies now, and so is the largest proportion of claims in the other mines. For particulars, as to shares, premiums, and capital invested, you cannot do better than consult the admirably compiled share list of Messrs. Hurly and Gray, advertised weekly in London in the *South African* newspaper.

The claims of this mine, which might have been purchased for three-quarters of a million about four years since, could not, when that valuation was made in the month of August, 1880, have been purchased for 3½ millions of money.

For some years the Du Toit's Pan and Bultfontein Mines were almost entirely abandoned, and a large proportion of the claims in both might have been held on payment of rent and water rates, and the license money. Within the last two years the high price of claims in the Kimberley Mine drove diggers to go elsewhere. Old De Beers, Du Toit's Pan, and Bultfontein were still open. A certain portion in each of these mines has always been worked from the time digging was commenced in them. Since, however, they have been worked anew, it has been discovered that they are all rich in diamonds—indeed the largest diamond that has yet been found, that of Mr. Porter Rhodes, lately exhibited to her Majesty the Queen, was found in the, I believe, Du Toit's Pan Mine.*

The value of claims in the Du Toit's Pan and Bultfontein Mines, and, indeed, of Old De Beers too, have risen in a most extraordinary manner during the last two years. Many a claimholder has grown rich from the rise in the value of his claims alone. Since the proprietors of the Du Toit's Pan and Bultfontein Mines, and their claimholders have had their differences adjusted, the whole aspect of affairs in these two places has changed, and claims that, a few years since, were but of nominal value, are now most valuable, yielding almost as well as the Kimberley claims, and are held in very high esteem in the market.

It is estimated that there is invested in the diamond mines of Griqualand West some millions of money; and to give you an idea of the yield of diamonds, I may here mention that the value of diamonds sent through the Post-office alone in 1879 amounted to £3,685,000. The returns of last year's exportation are not yet to hand; they will certainly show a higher figure than that which I have quoted for 1879.

I have hitherto spoken only of the Diamond Fields in Griqualand West, but as the subject is the Diamond Fields of South Africa, it may reasonably be expected that I mention, however briefly, the Jaggersfontein diggings. These diggings are situated near the town of Fauresmith, in the Free State. Diamonds had been found, and diggings commenced there many years ago, but the operations of that time not proving profitable, they were abandoned. About three years ago, digging was renewed there, and with at first moderate success. Latterly, however, the yield has been excellent, and the diamonds of very fine quality, and the Jaggersfontein camp, in all respects, resembles those I have before mentioned at the same stage of their history. Claims, at Jaggersfontein, which two years ago could have been had for a nominal figure, cannot now be obtained for less than for £900 to £1,200.

* This I have discovered to be a mistake. It was found in the Kimberley Mine.—R. W. M.

I have as yet said nothing respecting the labour question. The working of claims, whether on the river, or in the dry diggings, involves the employment of a very large amount of manual labour, and the labour question has been one which has at times been very difficult indeed. The chief part of the pick and shovel labour is performed by natives, and when I tell you that during the last seven years 640,000 natives, who never worked for wages before, have been registered as servants to claimholders in the Diamond Fields, you will imagine how vast is the work of diamond digging in the Fields. Holding as I do that the best and surest way to civilise the natives, is to induce them to work steadily and to work for wages, I consider that the Diamond Fields have done more to civilise the native tribes fifty times over than all other efforts and institutions put together. The native earns whilst working in the diamond mines, 12s. per week in money on the average, in addition to his food, which may be calculated at 10s. per week, making his total weekly earnings 22s. The raw native, when he arrives first in the fields, has no idea how to use a spade or pick; he comes lean, naked, and stupid. That he is so, is no fault of his. Let anyone, who has watched the course of events in the Diamond Fields, speak fairly, and he will say that this native labour has been turned to good account, both for the native and his employer. You will see to-day in the Diamond Fields thousands of natives as well-dressed as the agricultural labourer of this country, and in a great many instances a very great deal better—they are better clothed and better fed. The natives here build churches and schools for themselves, and a very fair proportion of them have, after going back to their chiefs once or twice, settled down in the Fields, and have thrown off the yoke of the chiefs altogether.

Of course there are great thieves amongst them; the moral law had never been any law to them before they arrived in the Fields, and in the hands of bad men they are cunning and dangerous thieves. I do not wish you to understand from me that all the 640,000 natives who have worked for wages in the Diamond Fields have become model men—far from it. What I do maintain is that whilst they have all been taught to work, a very large proportion of them have been civilised to a very much greater extent than anyone could have calculated on, and that that civilising influence is still going on, and producing marvellous results.

I have told you in what way diamonds were first discovered in South Africa, how the diamond diggings were commenced, and how, in spite of difficulties and complications, they have been settled. Let us see, now, what the discovery has led to, and what value the Fields have been to South Africa and to this country, and of how much greater value they may still be if rightly dealt with. I should like to show, also, to the members of the Society of Arts, that Art has already advanced by their existence. We have now, in a portion of South Africa, 600 miles from the colonial sea-board, and in a part of the country that was before producing nothing, a producing power which gives about £4,000,000 per annum of raw material for the market. It has already made the fortunes of a great many people, given profitable labour to thousands of white men, and taught 640,000 natives to work for wages. We have four large towns established round the mining centres, in which trade and commerce flourishes to such an extent, that two years since, when the last statistics were compiled, it was found that one and a half million pounds per year was paid for the carriage of goods to and from the ports. The principal town has a municipality, the revenue of which, derived chiefly from a rate on household property, amounts to over £25,000 per annum. Its effect upon the Customs dues of the Cape Colony and Natal has been, that whilst the import returns of Natal in 1870, were £429,527, they had risen to £2,176,356 in 1879; that the import duties of the Cape Colony has increased £5,000,000 during the same period. I should state here, that owing to the mining operations of the Du Toit's Pan Mine having increased so much, that the London and South African Exploration Company, the proprietors of the mine, have been compelled to lay out a site for a new town. To supply the town of Kimberley and its mine with water, a water company has been started with a capital of £350,000; and, I venture to say, that the profits of this company will far exceed that of any other water company in existence, and that the towns and mines can afford to pay for water being brought from the Vaal River, a distance of 14 miles, shows how great must be the industry and the population. These Diamond Fields find employment for three banks. A tramway is about to be laid down between the towns, and the two provinces of the Cape Colony are so much dependent upon the trade of the Diamond Fields, that they are competing with each other in the matter of routes for the trunk railway line, which is to connect the Diamond Fields with the Cape Colony. Those railways would never have been made but for the wealth which the Diamond Fields have yielded. The railways will be the means of opening up the coal fields which abound on all sides, and of which Sir Bartle Frere spoke to you in his lecture. It has led to the revival in England of that branch of art which had well-nigh been exhausted—the diamond-cutting trade. It is useless any longer to say that diamonds can only be cut in Holland. I saw yesterday in Clerkenwell, at the lapidary works of Messrs. W. Ford and Co., eighteen mills going, worked by steam, all employed in cutting diamonds, and the work done there—all English workmen—has been proved to be superior to that done on the Continent. I would advise whoever is curious to see how diamonds are cut, or who wish to have cutting done, for commercial purposes, to visit this establishment. This art of diamond cutting has established itself already in the Diamond Fields. Manufacturing jewellers, who worked for bare wages at home, are masters there. The fields are giving employment in the English manufacturing districts to thousands of workmen, and enriching the British manufacturer. These are amongst the results of this wonderful discovery. I hope the destruction of that government which Sir Henry Barkly gave the Provinces may not do it and the Fields all the injury that I dread. The annexation of Griqualand West to the Cape Colony is a blunder.

In the early part of my paper I said I would reserve what I had to say on the subject of the

land questions, which have been the most disturbing of all the questions which have been raised since the Diamond Fields were first discovered. Yours is "a Society for the encouragement of Arts, Manufactures, and Commerce," and I regard therefore this land question as one which should be brought under your especial notice. I have shown you how the development of the diamond mines has led up to the advancement of art and commerce already, and I want you to see how great a future there is in store for South Africa if she is fairly well governed. I have shown you some measure of what has been accomplished through the opening up of the Diamond Fields. I will now show what was left undone that ought to have been done. In the first place, seeing that Waterboer, and his father before him, had been our allies, and that the Griquas were as loyal to British rule as if they had been her Majesty's subjects, we ought to have prevented the Boers from over-running his country, immediately he complained to us, and we had ascertained that his complaint was well founded. Having neglected to do that, it was the more our duty to have taken over his territory promptly when he asked us to do so, after the Diamond Fields were open, and we saw that the Boers, both on the Free State and Transvaal side, were going into it to possess themselves of it. You may not know, but I do, that it was seven whole years after we had taken over his country before we had settled the claims of those who held titles to land in the territory made over to us, and that even Waterboer himself, who had made over the land to us, was forced into a Court of law to obtain titles to his own farms. I cannot say whose fault this was. I believe it came of Imperial instructions. I only know that it was not the fault of the Lieutenant-Governor of the province, and although I once thought that it was attributable to Sir Henry Barkly, I am now assured that it was not the case. I told you that for some time after the special magistrate arrived in Klipdrift, he was chiefly engaged with the settlement of land disputes. I told you too that before that time the Transvaal had sent a magistrate to Hebron, and claimed all the country down from the Transvaal proper to the banks of the Vaal River. The Transvaal, however, agreed to leave the borders of that territory to be settled by arbitration, Mr. Keate, the Lieutenant-Governor of Natal, being the final referee.

I now pray of you to give me your undivided attention whilst I explain how much depends upon the proper settlement of land and territory in South Africa. Sir Bartle Frere, when in the Diamond Fields, shortly before he left South Africa for England, after expressing his amazement at the wondrous progress the Fields had made, and the vast wealth evidenced on all sides of the mines, said that if the diamonds should fail to-morrow—but there was no fear of that—these towns would still prosper, for they are on the highway to the interior trade. Sir Bartle Frere said what was quite true. The Diamond Fields are on their way to the interior trade of Africa, and if we are to have the interior trade, we should hold it in our own hands as a precious gift not to be lightly disposed of. But it is useless to tell us that the Diamond Fields are on the highway to the interior trade if you permit the way between the Diamond Fields and that trade to be blocked up against British enterprise. If other people are to have the gold and ivory, the ostrich feathers, karosses, &c., don't tantalise British subjects in South Africa by telling them that they are on the highway to the interior trade. Let me call your attention to a rough outline map. Lieutenant Governor Keate was called upon to decide whether this piece of country belonged to the Transvaal Boers or to the native. The two arbitrators who represented the disputants had differed, and, judging between them, Lieutenant-Governor Keate's decision was that it never was the property of the Boers, but that it was native territory. The Transvaal Government, notwithstanding this decision, persisted in keeping a Court open at Christiana, and the Boers continued to come into the territory and take land just when they pleased. I must say that Sir Henry Barkly took a firm stand on this matter, but he was never permitted to settle the country, although the paramount chief of the Butlapins had asked us to take over his territory and protect his people. That chief had made it clear to our Government at one time that his people would be sacrificed to Boer greed for land unless he received British protection. The promise was made to him that his country should be annexed to the British Empire, and he was comforted. That promise has not yet been kept, and we are now in imminent danger of losing much that we have gained by the grand Diamond Field enterprise, as well as that we had gained by the annexation of the Transvaal. This territory is left open for the off-scourings of native tribes to settle in, to live by plunder, and ultimately to get strong enough to make war upon the borders of either the Transvaal or Griqualand West.

Had the land of the Griqualand West territory been settled and occupied when the British flag was hoisted, the Diamond Fields would not have been altogether dependent upon the Transvaal and Free State Boer for the meat they ate, and all the cereals and vegetable stuff they required. Had that land been settled, and the Keate award put into effect, as it should have been, Colonel Warren would have had a lighter task in South Africa than he had when he was Land Commissioner of Griqualand West. Officials are reticent, but let him speak out, and I warrant you he could tell such a tale of meddle and muddle as is seldom to be found elsewhere. Colonel Warren had first to unravel the land complications of Griqualand West, and then he had to fight the natives, who had risen in rebellion because they were dissatisfied at the manner in which they had been treated in reference to that very land. Then he tried to settle the Keate award territory, but he was baffled and prevented, and it remains unsettled to this day. I am afraid to proceed further with this matter, but I desire that the members of the Society shall see how important it is for the encouragement of Arts, Manufactures, and Commerce, that the highway to the interior trade of South Africa shall be kept open from the West Coast to the East, and from East to West.

APPENDIX.

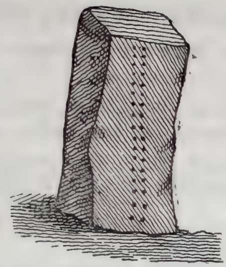
The Colesberg Kopje.

Stand upon the brink of the Colesberg Kopje—that

great mine of wealth, one of the marvels of modern discoveries—and try to convey a picture of it to the mind's eye of those who have never crossed the Orange River. The task will not be an easy one; ten chances to one against your satisfying yourself that you have made others see what you see every day in the week, and are as familiar with as you are with the fingers of your own hands. But try, for all that; for there are tens of thousands of people who talk of the Colesberg Kopje every day, wonder what it is at all like, and wish they could only make out. Ask them if they have been to London. If they have, tell them to think of the London of the present day as they saw it last, or as they look upon it now, with all its palaces, theatres, churches, bridges, railways, tunnels, monuments, and statues, with St. Paul's, and its dome, and its golden cross included—aye, with all its streets, too, and its traffic, its broad and mighty Thames, rushing through the piers of the bridges that span it, and carrying ships and wherries on the face of its murky water. Tell them, when they have that picture well in their mind's eye, to imagine it all swallowed up by one sudden shock of an earthquake—sucked down into the earth as it now stands, and buried a hundred feet deep at least, and there left for ages, with all its palaces, gaudy-coloured shop fronts, its flaming column on Fish-street-hill, its river and its green parks. Think of what it would be like if, when after centuries of interment, the vast city, with all its inhabitants, had been turned into stone—one vast brown fossil, with none of the colours that now delight the eye; nothing but the forms left of everything;—that then sixteen thousand men should set to work in the centre of it all, excavating, as men have done at Nineveh, to reveal to another age the buried remnants of the past. That is to me what the Colesberg Kopje looks like. I know that there was no city buried there; but as I stand and look into the great cauldron below me, it needs no effort of fancy to trace out old cathedral doors and windows on these temples not made with hands, which are standing out in giant masses of rock from the surrounding excavations; bridges which might have spanned rivers; columns which one would think had borne the statues of heroes of a by-gone age; palaces that might have been sucked into the earth when Nature in convulsions set about making diamonds. There are, as I stand here, architectural patterns before me which it is difficult to believe are but chance lines that were made without one thinker to guide them. There is in one place as perfect a picture of the side of an old abbey, with its fantastical windows and carved doors, as if Westminster had been buried here, and had now been brought to light again. On an embankment that swarms with life, seventy feet below where I stand, are great masses of material, piled in blocks, lying in all fashions, some of them like broken rafters, halves of wheels, roofing and flooring. There are thousands of living beings climbing out of it and creeping about it. It bears a most perfect resemblance to a railway accident I once saw, and I have some difficulty in divesting my mind of the picture that had long ago passed away from my memory, and is only now again revived. A hundred fancies crowd into one's mind as one looks into and around the Kopje. It is impossible that it can be otherwise; it is so unlike anything else that one has seen, and it grows more and more wonderful every day. This time last year there were roads leading across the vast abyss, and connecting the sides and roads with each other. Carts and horses and men crossed and recrossed daily. Now the roads are gone; the stuff of which they were made has been reduced to fine sand, and men who then sometimes prayed for their daily bread, as if they knew they prayed in vain, worked for it with desperation, and for a long time almost in vain, are now living in luxury upon the proceeds of the precious stones picked out from the roadways. Not a road now intersects any portion of the Kopje; it is one great dock, that would take the whole of the Table Bay dock and breakwater, and hide it away in one of its corners. It is but fanciful to picture the Kopje in this way; but, as far as the eye can see, it is just what I have written of it.

It needs a firm nerve to stand upon the brink where I am now standing, and look through the running gear—the great network of ropes that cover the face of the Kopje, as it were a spider's web spread over the whole—and, in the midst of the great buzz, to take a calm survey of the work going on. I have seen strong men tremble and clutch the staging whilst they looked into this great human ant-hill. I have heard them say they felt bewildered; and no one could wonder that they did. The giddy heights, the noise, the bustle, the elbowing, are sufficient to bewilder anyone. If all the drones in the world had been driven into the Kopje, and all their droning powers had been increased a million times, the noise could not have been more deafening. If a hundred towers of Babel had been brought within one man's hearing, the confusion of tongues could not be greater. There is here every type of man under Heaven. There is the military man, who has dropped his uniform for the digger's cut, the navvy, the scholar, the gentleman, the man once about town, the young Africander who once only rode the high horse, the young Englishman who never worked with anything heavier than a billiard cue before he came to this place, the doctor, the divine, the lawyer, the lamp-lighter. Here they are all thrown in together, all reduced to one level, all working alike with barrow, pickaxe, and crowbar. There is no classifying them. For all that anyone can see to the contrary, they might all be nameless convicts reduced to a number. When they heard of picking up diamonds in Africa, they could never have dreamt of such work as this, or they would never have been here.

There is not a native tribe in Africa of which there are not hundreds of specimens at work in this Kopje. There is the stalwart Mohow, sleek of skin and supple of limb, some of them like giants, tearing away the blocks of rock and soil for their white masters; the ill-formed, feeble, weedy Koranna; the intelligent Zulu, and the industrious Basuto. Of the twelve thousand at work, there are ten thousand natives, and of the ten thousand one-half work from morning till night, and all the year round most of them, as naked as they were born. Those who dress, dress most fantastically. Some are digging; others toiling at the wheel-barrows, which they drive along ridges that a goat would scarcely care to cross; others work upon little ledges of rock, high up where none can help them. Some stand on the summit of pillars sixty feet in height, and not broader than a man could stride. Here they work with their crowbars and picks with as much unconcern as if they were in the centre of a ten-acre field. You wonder how they got there, and wonder still more how they are to be brought down again. Whilst you look, one of them has to come down to fetch something, possibly a bit of fire to light his pipe with, or a drink of water, or a heavier crowbar than the one he has been working with. He drops his tool, sits on the edge of the narrow platform on which he has been at work, puts his feet over the side, turns himself round, and lies for a second or so with his toes just over the side, feeling for something. You can see little dark spots that dot the sides of the mass of rock upon which this man and his mate have been working. This mass of rock was once part of the roadway which has been removed, and it is now a pillar of ten feet square, or thereabouts, standing fifty feet high, with nothing to support it. It is down the side of this that the man is coming. The barbarian who is descending has no need to fear that he shall either soil or spoil his clothes, for he has nothing in the shape of clothes upon him but a rag of about the size of an Adam fig-leaf, and an old felt hat with a feather in it. The spots you see in the sides are foot-holds which run down in pairs in this way:—



The feet having caught the two first holes, the man descending gradually lets himself down step by step, until he is able to grip the first two holes with his hands, and then he comes down as easily as if he had a flight of stairs to descend, with a pair of banisters on each side of him to hold on by. But if the rock, which is about as soft as unburnt brick, were to crumble away from one of the footholds, or the edge of the platform were to give way when he lays holds of it to lift himself up to his work again, he must be dashed to pieces, for there is nothing to save him. But it is with the diamond-digger as it is with the grave-digger,—

"Custom hath made it in him a property of easiness."

Some of the men get to work in these awkward and dangerous places by means of ladders, some rope-ladders, and some the ordinary builder's ladder. Never has a native met with an accident in going to and from his work by means of the holes cut in the rock; but there have been many accidents from climbing up rope and chain-ladders. One that took place a few months since will best serve to show the kind of work these men have to perform. A resident of Cape Town had been a long time working unsuccessfully. Friends knew that he had a family in Cape Town dependent on him for support. They saw that he was desponding, and at last one offered him a claim to work on shares. He went down to see it. It was a very deep claim indeed, and the bottom was reached by going down a ladder made of chains and rope, from the top to a ledge fifty feet below the surface. From that ledge there were ladders of wood that went from ledge to ledge, until the bottom was reached. He had gone down safely, looked at the bottom gravel, taken samples of it, and came up all right to the ledge upon which the rope-ladder rested. He looked up, and feeling his nerves fail, lit his pipe and smoked a few whiffs. He then proceeded to mount, but when he was within fifteen feet of the top he felt his nerves suddenly give way. He thought he could not reach the top, so he slid down again to the ledge, smoked his pipe for a little while, and then made a second attempt. When within ten feet he became giddy. The ladder here was fixed to a chain, which he had to come up hand over hand; he felt he could climb no more; his nerves utterly failed him, and he slid down again, reached the rope-ladder all right, but when he was within about ten feet of the ledge the rope-ladder and chain parted, and he fell with the piece of rope in his hand. He was fearfully smashed, but he lived to tell the tale.

Men have had frightful falls without being much injured. One man fell over fifty feet, and came up only a little bruised. A man, aggravated by another, threw him down his claim, between forty and fifty feet deep. The fellow came up again as lively as a cricket; he was not even scratched. The greatest danger to be now apprehended is from the falling in of the reef. Several pieces have fallen in, and men have been buried in the ruins. It has been predicted that the staging will yet fall in; and if that were to take place, thousands of lives must be sacrificed. There have been fearful slips since then, and many lives have been lost, both of white and coloured men.

DISCUSSION.

Mr. James Price, in offering some remarks on the able paper which had been read to the meeting, would not attempt to criticise it, recognising as he did the amount of information contained in it. Mr. Murray had brought before the meeting details of the history of the South African Gold and Diamond Fields, which had not previously been made public, but which he had been able to give from his personal knowledge and experience. No doubt the Diamond Fields would have a very great effect upon the future of South Africa, and their existence would facilitate the creation of roads in the country, and would assist in opening up the interior to commerce. New fields were greatly required for our manufactures. One very important matter in connexion with the Diamond Fields was the employment of native labour. The natives were now taught to work, and native labour would in future be an important element in opening up the territory. They were now taught to wear clothes, which were sent as manufactured goods from this country; and, as the habits of labour and the requirement of clothing became more recognised, wider fields of commerce and for the consumption of English manufactured goods would be opened. Of the immense value of the Diamond Fields no doubt could be felt, seeing that the proceeds sent to this country amounted to £4,000,000. Probably many of those engaged in cutting the diamonds sent from Africa were present, and to them the paper would be specially interesting, as there had now been restored to this country a trade of which the Dutch had hitherto had almost the exclusive monopoly, and it was to be hoped it would become more and more developed.

Mr. Pfoundes questioned the pertinence of some allusions to Australia, which occurred in one or two paragraphs of the paper. He had been a resident in Australia for many years, and could testify, from his own experience, to the general high character of the Australian colonists.

Mr. Charles Frazer thought the paper presented so perfect a photograph of the parts of South Africa with which it dealt that it could hardly give rise to any discussion. It would be especially valuable to the industrial section of the community, as showing them what an excellent field for their labour South Africa presented. That remark would certainly apply to almost every colony in her Majesty's empire; and if the paper should be the means of inducing the agricultural population of this country to emigrate, it would be a benefit generally to the empire. Out of about 16,000,000 people in this country who laboured with their hands, at least 60 per cent. were idle for two months in the year, and assuming, for the sake of argument, that they earned about £2 a week all the year round, by the dearth of employment each man lost about £16 in the year, which sum, multiplied by 16,000,000, showed not only the aggregate loss to the working classes, but a loss of purchasing power which affected the entire manufacturing interests of the country. He would therefore say to the working classes of this country, "emigrate by all means." He, too, was an old colonist; and Mr. Murray would recognise in him one who stood beside him when the Diamond Fields were looked upon as a myth, and when the leading merchants in South Africa would not even advance £10 towards exploring them, so doubtful were they of any return to be obtained from them. If the paper should have the result of inducing working men to go out to that country, it would have achieved a worthy object, and one which he believed Mr. Murray had very much at heart.

The Chairman entirely agreed that the paper showed a high degree of thoughtfulness, and that it could not but be attended with a good result. Mr. Murray had told, in the plainest and clearest way, the history of that wonderful province, which though one of the smallest and most

recent, was certainly one of the most remarkable among the dependencies of the British Crown. Scarcely anything in books of imagination, or even in the "Arabian Nights," was more wonderful than the story that had been narrated in the paper. That a tract of veritable wilderness should become more valuable and wealthy than the most valuable centres of the wealthiest capitals in the civilised world, was a fact that seemed hardly credible, but these Diamond Fields, in a remote desert, had, in truth, become more valuable than any land in the centres of civilisation. Another interesting fact disclosed by the reader of the paper was the connection established between the highest civilisation and the depths of barbarism, for they found that, by an extraordinary chain of circumstances, high art, science, and even luxury, were contributing in a remarkable way to elevate the natives, and to ameliorate their condition. Those who, in the great cities of Europe, India, and America, spend their surplus wealth in the purchase of diamonds, contributed, perhaps little knowing it, to the improvement, in a wonderful degree, of the natives of South Africa. Missionaries, good men as they were known to be, must, after all, teach the native that his condition can only be improved by labour. The civilising influences in all countries were really the spade and plough, and colonists who taught the natives to labour, were as true pioneers of civilisation as any other class of men. In that respect, therefore, the colonists of Griqualand West, who were employing native diggers were rendering yeomen's service to the cause of civilisation. A very fair remark, he considered, had been made by the gentleman who spoke on behalf of the Australian colonies, but he did not suppose for one moment that Mr. Murray intended to throw any shadow of reproach upon them. It was of the highest possible consequence that the colonists of every colony of the empire should endeavour to work amicably and conjointly together, because after all, the empire depended to a great extent upon its colonies, and the day was not far distant when those colonies must be brought into closer contact with each other, and with the mother country. That result could only be brought about at an earlier date, as contrasted with some distant period, by their striving together in a common work. It only remained to propose a hearty vote of thanks to the author for his paper.

The resolution was carried unanimously.

Mr. Murray, in acknowledging the vote of thanks, said that he had no more intention of reflecting upon Australia than upon California, or upon South Africa itself. All he wished to point out was the comparative amount of crime in the colonies, not committed by the colonists themselves, but, as in the case of California, by the waifs and outcasts which had drifted there from all parts of America. As he had told them, though there were but few ports in South Africa, they received some outcasts from society as well as America. He had certainly no intention of reflecting upon Australia, which he himself held to be one of the gems and great glories of the empire. He was greatly obliged to the meeting for the attention they had given to his paper, which showed that they realised the importance of the subject brought before them. Whatever the character of the seed he had attempted to sow might be, it had been sown in good soil, and he was especially glad that so many of the industrial classes were present, for it was his great desire to assist labour as far as lay in his power. He felt that he had far from exhausted the subject or done it as much justice as it deserved, but he had done his best to present a plain narrative of the history of the South African Diamond Fields in the time allotted to him, without wearying the audience with dry details and statistics. At some future time he hoped to be able to fill up the gaps left in the paper.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 16th, 1881; Lord Alfred S. Churchill in the chair.

The following candidates were proposed for election as members of the Society:—

Adlam, James, 28, Aldebert-ter., Clapham-road, S.W.
Beaumont, Colonel F., R.E., 3, Victoria-street, Westminster.
Browne, Harold C. Gore, M.A., 6, New-square, Lincoln's-inn, W.C.
D'Avigdor, E. Henry, B.A., Derwentwater-house, Acton, W., and 15, Great George-street, S.W.
Donaldson, J. Hunter, 176, Oxford-street, W.
Greenhough, David William, 9, Mincing-lane, E.C.
Henry, Ebenezer Walker, 27, Belsize-crescent, Hampstead, N.W.
Maberley, Capt. Thomas Astley, 25, Parliament-street, S.W.
Mansfield, George, 104, New Bond-street, W.
Potts, Benjamin L. F., A.M.I.C.E., 174, Camberwell-grove, S.E.
Price, John Edward, F.S.A., 60, Albion-road, Stoke Newington, N.
Welsh, Thomas Debell, 79, Arthur-road, Brixton, S.W.

The following candidates were balloted for, and duly elected members of the Society:—

Appleby, Herbert, Durnlea, Littleborough, Lancashire.
Attwood, George, F.G.S., F.C.S., 7, Ulster-place, Regent's-park, N.W.
Hall, W. H., Weybridge-heath, Surrey.
Rattray, Netlam, 70, Gloucester-terrace, Hyde-park, W
Richardson, Captain John Frederick, Ph.D., J.P., Houghton-house, Stoneygate, Leicester.

The paper read was—

THE BEAUMONT COMPRESSED AIR LOCOMOTIVE FOR TRAMWAYS, RAILWAYS, &c.

By Colonel F. Beaumont, R.E.

From the earliest ages, the importance of facilitating locomotion has been recognised, and the civilising effect of interchange, whether of men or material, has been increasingly appreciated as greater facilities have become available. After the introduction of wheeled vehicles, the first notable step forward was by macadamising our roads, thus enabling coaches to be run at speeds till then unattainable. Three days was the time between London and the "Old Black Swan" at York, as testified by the placard over the bar. Before steam superseded coaches, the latter ran at twelve to fourteen miles an hour. Rails were known before the introduction of steam upon them, but the full value of reducing the rolling resistance of carriages to a minimum was never properly appreciated by the public till steam rendered great speed a possibility, and consequently caused smooth tracks to be an absolute necessity. The introduction of the iron rail became general when it was found that not only would the cost of transit be reduced, but concurrently a speed would be possible quite unattainable with horses.

After railways, tramways form the next forward step in the progress of locomotion. I understand the difference between a tramway and a railway to be that the former is used for lower speeds, while thus enabling cheaper works to be constructed, the tram-car shares the road with other vehicles; whereas the latter carries a high speed traffic ex-

clusively its own. The conditions under which the two systems have to be worked are dissimilar, and their relative advantages and disadvantages may be put down as follows:—

The railway commands all the movements on its line, and can so choose its own rate of speed, limited only by considerations of safety. It has, if the most expensive in first cost, certainly the most perfect means of reducing to a minimum the working expenses of carrying a large quantity of traffic, while it enjoys the monopoly of high speeds. On the other hand, its cost is enormous, and the standing charges necessarily heavy. Its system is inelastic, and until a railway has actually made traffic for itself it cannot pay. It is usually computed that it takes seven years for an average line to create a remunerative business—or, in other words, a travelling public around it—sufficient to enable it fairly to rank as a paying concern.

In the case of a tramway—assuming the rolling resistance to be something not very far from a railway, and that a means is found of applying mechanical in place of animal power—how will the comparison stand? It is cheap to construct, and it has no land to pay for. It must accommodate its traffic to that of the road, and, consequently, can only move slowly. It is able, however, to adjust its working expenses, to a certain extent, to the work it has to do; and it taps traffic and districts which a railway cannot touch. On the other hand, it labours under the great disadvantage of bad gradients, and the obligation to divide its haulage into small portions, thereby necessitating the smallest, and consequently the most expensive, form of engine. Notwithstanding these circumstances, it appears to me that the tramway system ought to become a formidable competitor to railways for a certain class of traffic, provided horseflesh can be superseded by mechanical power. A little consideration will show that a tram engine must work under conditions enormously less favourable than those of an ordinary locomotive. To put this clearer—take the case of a fast train running out of London—say, on one of our main northern lines. An engine drawing such a train will need to do the work of 1,000 horses, and during its journey, so far as gradients are concerned, it will not be required to vary its power more than to a moderate extent. The engine will cost £3,000, which must be set against the cost of 1,000 horses at £40 each—say £40,000. Of course these figures are only used for the purpose of comparison, and do not refer to the number of horses required to continue doing the same amount of work. Now a tram-car is actually drawn by two horses, value £80 (about 10 horses per car are required for continuous working), for which it is proposed to substitute an engine at a cost of £700. Moreover, owing to gradients, the engine will require to vary its force very largely, and power has to be provided corresponding to the maximum inclination, however small a proportion the incline may bear to the rest of the road. A tram engine is, therefore, in a much worse position than a railway locomotive for showing economy as against horses, and this irrespective of other important considerations, such as unusual wear and tear from its machinery being close to a muddy road, or the shaking due to running on an uneven track.

The great difference between a steam-engine for tramway and ordinary locomotive purposes, arises from the necessity which is thrown upon the tramway engineer to fulfil certain requirements which are not needed in the case of a locomotive. They will be readily understood from a perusal of the requirement of the Board of Trade, as laid down in the report of the House of Commons Committee on the application of mechanical power to tramways. The difficulties arise from the small space available, and the absolute necessity of avoiding the emission of smoke or steam, the machinery, too, requires to be completely covered; and certain mechanical controls are asked for on the tram engines, which are never used on ordinary locomotives.

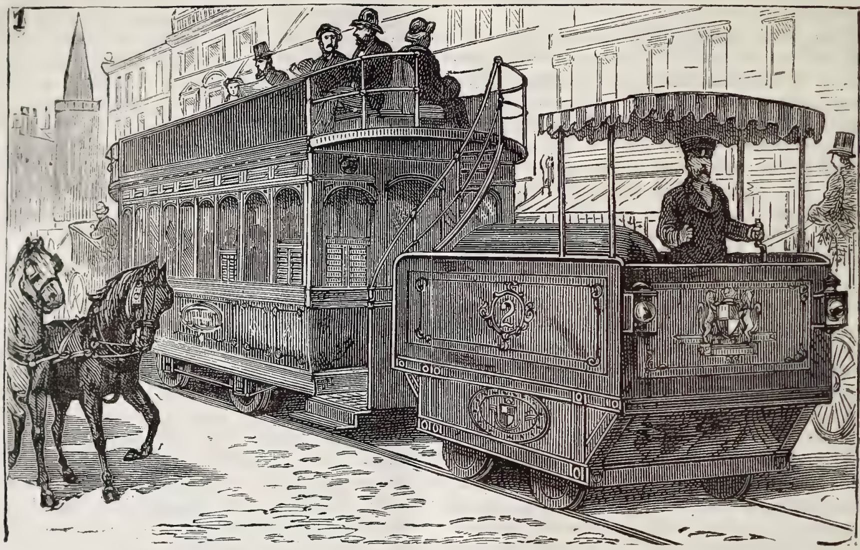
The difficulty in these connections will be recognised, when it is considered that a detached tramway engine weighs, say, seven tons, and stands on a small wheel base. Within this, a powerful engine and boiler has to be arranged, with the pumps, injectors, brakes, arrangements for condensing, and other details. To this is added an automatic brake, with regulator and speed indicator. The driver, therefore, has no inconsiderable number of handles within his reach, the manipulation of which he is responsible for. Moreover, these must be so arranged that they can be worked from either end of the engine. Any arrangement for condensing the steam, involves weight and complication, while the smoke can only be killed by a proper choice of fuel.

With reference to the second point, unfortunately, though smoke may be avoided by a proper choice of fuel, it is quite impossible to stop noxious fumes.

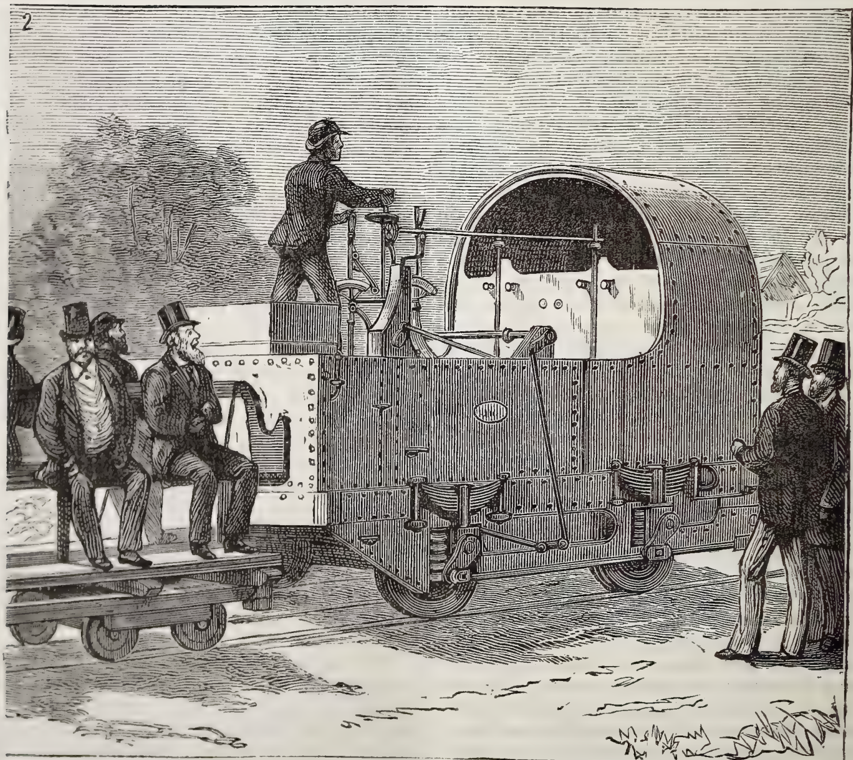
I make the above remarks, as it was from a consideration of the requirements necessary to meet the case, and an appreciation of the great difficulties in the way of steam, that I turned my attention to air. The reasons are obvious which recommend compressed air as a motive power. It is noiseless; it is smokeless; it is cleanly; it offends neither the ear, the eye, or the nose. A service of air-cars would be run in the following manner:—At intervals of every 10 miles compressing stations would be established, where the air would be compressed to the requisite amount by steam, or water power where available. These stations need not necessarily be on the tram line, as no loss worth noticing would be incurred by carrying the compressed air any reasonable distance, provided pipes of a suitable size were used. The charging would be done from a connection to be made between the engine and a tap, in a suitable box placed between the tramway lines beneath the road, of no more inconvenience to the public than a water hydrant.

There is nothing new in the proposal to apply compressed air to locomotive purposes, and when the advantages are so obvious, it is not remarkable that many efforts have been made to overcome the one weak point, viz., the difficulty of arranging so that a sufficient amount of power is available for practical purposes from the storage of a reasonable bulk of air.

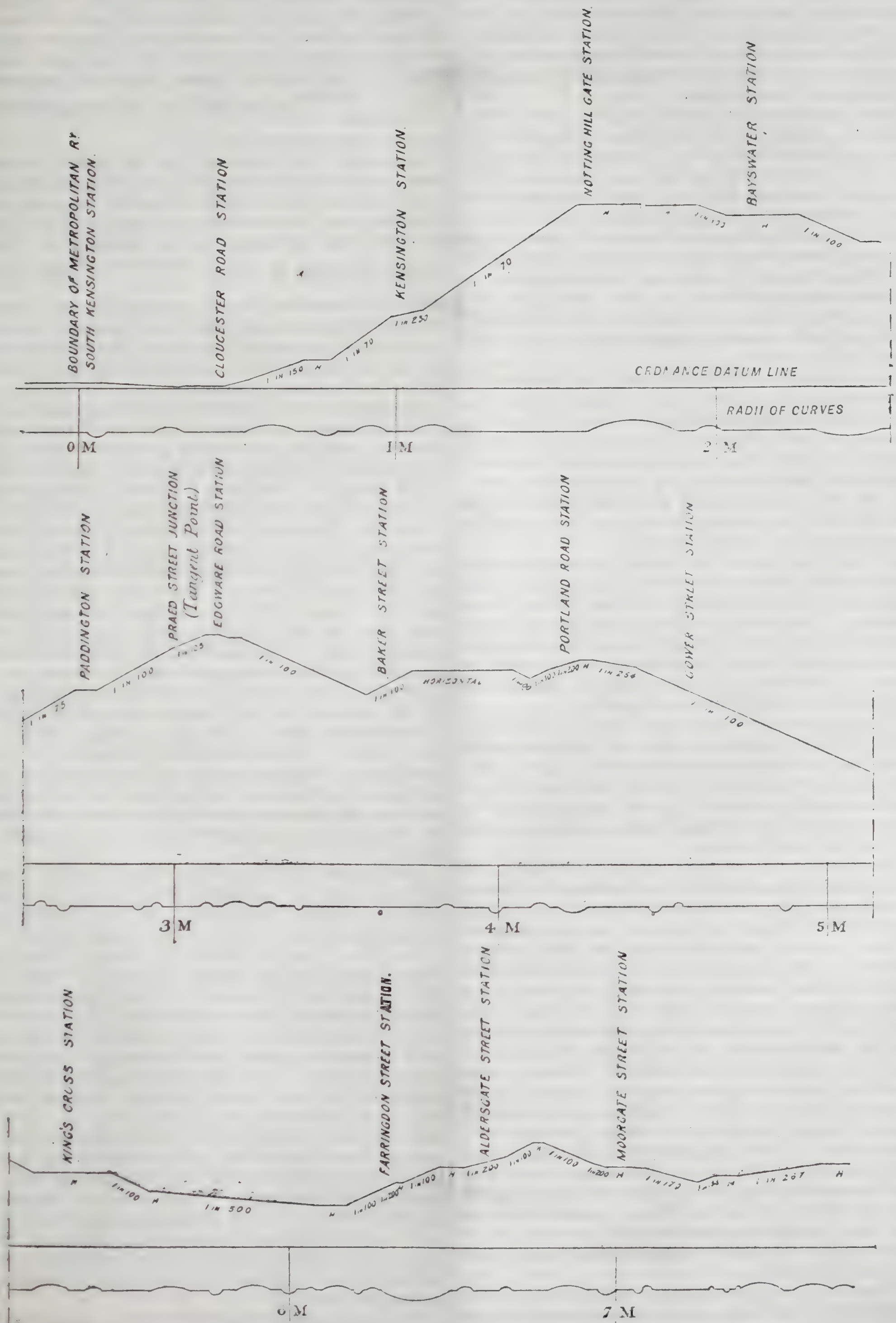
The earlier efforts were confined to simply compressing air at a comparatively low pressure, say 200 lbs. on the inch, in a suitable receptacle, and allowing it to expand into the working cylinders of an ordinary air-engine. It is impossible thus to get a satisfactory result, as a glance at the tables on



The Beaumont Compressed Air Engine.



Experimental Engine.



SECTION OF METROPOLITAN RAILWAY RUN OVER BY THE BEAUMONT AIR ENGINE.

the wall will show the small quantity of power contained in a cubic foot of air at 200 lbs. Further, if no means are taken to supply heat, there will be a very serious loss of power from the cooling of the air during expansion, as will be explained further on; and, besides, the engine would soon be stopped, from the ice which would form in the ports of the cylinders, and block them.

More recently, far better results have been obtained, getting over the latter difficulty, by mixing steam with the air. This formed the subject of a very early patent, now expired. The machines, however, still use low pressure air in the cylinders, some form of reducing valve being employed to reduce the high reservoir pressure to the low pressure at which the air is admitted to the ordinary working cylinders of the engines.

These two specialities, viz., the mixing of air and steam together, and the use of a reducing valve, are both absent in my engine, which I will now briefly describe.

The engine is constructed so as to admit the full reservoir pressure, no matter how high it may be, direct to the working cylinders of the engine, without any wire-drawing, or, in other words, loss of pressure whatever; and arrangements are made by which the heat necessary to prevent the formation of ice, and to keep the temperature from falling during expansion, is supplied by externally steam-jacketting the cylinders.

A small generator is carried in a convenient corner within the framework of the engine, which supplies a sufficient amount of steam for the above purpose. The steam, which is condensed by the expanding air, runs back into the boiler; hence no pump is needed, and the grate area is so small as to be of absolutely no inconvenience; the whole apparatus is completely out of sight.

The engine is provided with variable expansion gear, which works distinct from the positive action given to the valves by the eccentrics. The expansion arrangement works so efficiently, that the air can be entirely shut off by its use; indeed, the driver controls the engine by the expansion, and not by the throttle valve.

The pressure I am working at is 1,000 lbs. on the square inch, and the sizes of the cylinders are so arranged that, even when the engine is working considerably above its normal power, there is cylinder capacity sufficient to allow the air to be reduced to the atmospheric line before it is discharged, thus ensuring the whole of the energy which is stored up in it being made available. The power of the engine remains practicably constant till the whole of the air in the reservoirs is exhausted down to the working pressure, thus rendering unnecessary any special reserve of air for mounting inclines. This is effected in the following way:—The power developed at any given reservoir pressure is in direct proportion to the quantity of air consumed; the use of the expansion valve, together with the power of admitting a sufficient amount of pressure direct from the reservoir into the big cylinders, enables the quantity of air consumed to be varied in proportion to the work required to be done.

There is, of course, no particular virtue in the pressure of 1,000 lbs., and it was arrived at by me in the following manner:—I found from inquiry amongst tramway authorities that, though there were many short lines, any system of mechanical traction, to ensure its general adoption, should be capable of running ten miles without refilling. To be on the safe side, I take the resistance to traction on a fair and level tramway at 25 lbs. per ton, assuming a gross load to be drawn of 12 tons—say engine, 7 tons, and car 5 tons. This will require $\frac{12 \times 25 \times 50{,}000}{33{,}000}$ = say 500 h.p., to be magazined to go a distance of 10 miles.

Assuming that one-third of the total power stored up in the air could be rendered available, it will be seen that, with a reservoir capacity of 100 cubic feet, it is necessary to magazine the air at 1,000 lbs. pressure, to be master of the required amount of work, $\frac{100 \times 15}{3} = 500$ h.p. If 500 lbs. pressure is used, at least 200 cubic feet of reservoir must be provided, and in either case a much larger amount will be needed, if a further loss has to be incurred by wire-drawing from the higher to the lower pressure.

The engine stops and starts with the same ease as an ordinary locomotive; the use of the high pressure enables, in the high pressure portions of the engine, very small cylinders and valves, with slight travels to be used; hence I consider the machine will be found peculiarly economical in point of repairs. The cylinders and valves of the engines already made have never required to be touched, and there has hitherto—after extended trials—been no sign at all of wear. The joints require well making to stand 1,000 lbs. pressure, but once made they can be relied upon. With any system of storing power by compressed air, it is absolutely essential, not that leakages should be reduced to a minimum, but that there should be actually none. By the courtesy of the Arsenal authorities, I was able to satisfy myself that this condition could be relied upon. In the laboratory department Mr. Davidson is daily using air at from 1,000 lbs. to 1,500 lbs. pressure, and he has assured me that its use gave him no more trouble than steam, now that the arrangements necessary to be made were understood.

I will now summarise the results which have been obtained in actual practice with my engine, and then offer a few remarks on the theoretical conditions involved in the use of compressed air.

The No. 1 engine, made by Messrs. Manning, Wardle, and Co., of Leeds, was run for three or four months in the grounds of the Royal Arsenal, Woolwich, where in course of continual work it drew a gross load of 22 tons—11 miles, and 12 tons —21 miles respectively, with one single charge of 100 cubic feet of air. It subsequently made a trip of some 16 miles on the South Eastern Railway, from Dartford to Woolwich and back. It was then run on the Metropolitan (Underground) Railway, and a section of the line passed over has been kindly furnished to me by Mr. Tomlinson, and is appended to this paper. The engine and carriage together weighed about 20 tons, and over that line, with some fairly heavy curves and gradients, the duty done was three tons conveyed one mile, for an expenditure of one cubic foot of air, at 1,000 lbs. initial pressure.

The same engine, weighing ten tons, has shunted a 42-ton Metropolitan engine, with its steam down, and on a very bad road, thus showing its power.

At the works of Messrs. Adamson and Co., who have made the reservoirs I am now using, the engine was lifted off the ground and put under a dynamometer, and an actual result was obtained close on 6 h.p. (for one minute), for each cubic foot of air expended, from 1,000 lbs. This is about 33 per cent. of the h.p. expended in the work of compression.

A No. 2 engine, specially made for tramway purposes, with a reservoir capacity of 60 cubic feet, will very shortly be at work, under a contract with the North Metropolitan Tramway Company, to work their Stratford, Leytonstone, and Epping Forest line. It has been tried most successfully on the Leeds tramways, and also for shunting purposes at the Victoria Docks. I append a statement by Mr. Carr, the engineer to the Docks, of the work done. It will be noticed that the result shows three tons moved one mile, for the expenditure of each cubic foot of air:—

"January 27.—Air-compressed locomotive made for tramway rail, weight about 7 tons, working on a piece of straight level line in the Royal Albert Dock, back of No. 35 shed, 100 yards in length, drawing an open truck weighing 5 tons laden with $11\frac{1}{2}$ tons of brick rubbish. Total weight moved, including engine, $23\frac{1}{2}$ tons (engine 7 tons, truck 5, bricks $11\frac{1}{2} = 23\frac{1}{2}$ tons). The engine was reversed at every journey of 100 yards. The pressure in receiver at starting was 925 lbs.

	Air pressure.		Minutes.		Lbs.
405	925 lbs.	ran 1,000 yards	in 9,	reduced pressure to	805
	805	,,	,, 9,	,,	730
	730	,,	,, 9,	,,	660
	660	,,	,, 13,	,,	595
	595	,,	,, 10,	,,	520

5,000 yards run. Loss 405 lbs. in 50 min. 3 miles 73 yards per hour.

	Air pressure.		Minutes.		Lbs.
315	520	,,	,, 10,	,,	435
	435	,,	,, 10,	,,	360
	360	,,	,, 10,	,,	288
	288	,,	,, 10,	,,	205

4,000 yards run. Loss 315 lbs.

Thus a gross load of $23\frac{1}{2}$ tons was taken a distance of nearly $5\frac{1}{4}$ miles, with a diminution of 720 lbs. from an initial pressure of 925 lbs. per square inch, in a reservoir having a capacity of 60 cubic feet. This is equivalent to an expenditure of 42 ft. of air at 1,000 initial pressure, which represents for the work above mentioned a duty of (say) 3 tons conveyed one mile for each cubic foot of air consumed. The line was straight and level, but, on the other hand, 90 stops and starts had to be made in the distance run.—ROBERT CARR."

These results have been got with engines that are, perhaps, a little stiff, owing to their not being yet in regular work. From this cause, and by using certain improved arrangements for getting more heat into the air during expansion, I anticipate obtaining better results than the above. Taking, however, the trials as they stand, they mean that the expenditure of from $\frac{3}{4}$ to 1 lb. of coal will take 3 tons 1 mile on an ordinarily level railway, or develop 6 h.p. for 1 minute under a dynamometer.

The compressing engines now erected at Stratford, were indicated at Messrs. Adamson's Works, and it was from the results there obtained that the above estimate is made of the coal required to produce one cubic foot of compressed air.

The use of compressed air, as ordinarily understood, means only the reproduction of the power expended in the act of compression, whether steam or water be the agent employed. This, however, is not strictly true with reference to the latest form of engine, as heat is supplied to the air during expansion, thereby supplementing the store of energy received from the original source.

As mentioned earlier, the whole difficulty in connection with the use of compressed air arose from the loss of power involved in the way in which it has been hitherto used. The *rationale* of this is as follows:—Heat and power are exact mechanical equivalents, as shown by our talented countryman, Dr. Joule; or, to put it more plainly, any expenditure of power produces heat, a corresponding amount of cold being developed in the source of energy. This being so, the air, as it is compressed, receives the heat due to the mechanical energy employed in compressing it; and, in accordance with a well-known law, the pressure increases in proportion; as it is impracticable to keep the temperature of the reservoirs above that of the atmosphere, it is lost. When the air, in its turn, becomes the working fluid, the energy developed requires heat, which must be obtained (if no external source is available) from the air itself, the cold produced, or rather the heat abstracted, being in exact proportion to the power given off. It will be seen from this that, if arrangements are made to withdraw the heat of compression, and supply an equal amount during expansion, the power given off by the working engine will correspond with that absorbed by the compressors, the expansion and compression curves being on isothermal lines. It is to supply this heat that the cylinders of the engine are jacketted with steam; each unit of heat abstracted from the steam prevents a corresponding drop of temperature, and, consequently, of pressure in the working cylinder; in other words, it is turned into mechanical energy. At the commencement of my experiments, the doubtful point was whether a sufficient amount of heat could be got through the walls of the cylinders to materially affect the temperature of the air within. That my system effects this is shown by the air being exhausted at about 100° Fahr., when the engine is doing a normal amount of work, and by the reduction of steam pressure in the small generator, which takes place directly the locomotive is started, showing that the energy produced in the cylinders absorbs heat, which is abstracted through the metal of the cylinders from the steam surrounding them, a corresponding amount of which is condensed, and trickles back as warm water to the generator to be revaporated.

I have not yet had an opportunity of indicating the cylinders either for temperature or pressure, owing to the high pressure used necessitating special appliances, but I hope shortly to be able to do so, when a proper curve of expansion could be laid down. It will be noticed that any admixture of air and steam must be a source of loss if the same temperature could be got without it by external jacketting, as, in the former case, hot water would be discharged into the atmosphere. For the purpose of proving the correctness of my views, I introduced, as an experiment, steam into the second cylinder of my No. 1 engine. The pipe supplying it was furnished with a back valve, so that, while the air could not enter the steam pipe, the steam could mix freely with the expanding air, so soon as the pressure of the latter was below that of the former. Just as much steam was admitted as could be done without its showing at the exhaust. Comparative trials were made with the same engine, worked

under the two circumstances, at the works of Messrs. Manning, Wardle, and Co. (the makers of the engine, at Leeds), and it was found that no gain in effect was produced by mixing, whereas the convenience of the original arrangement was obvious; it was therefore finally adopted. The temperature thereby obtained is amply sufficient to keep the lubricating medium employed in a proper condition, and there is absolutely no difficulty at all in practice from this cause.

The Table below shows very clearly the importance of avoiding the loss which a reducing-valve entails, viz., a direct loss of no less than two-thirds of the whole energy stored up, if the air at 1,000 lbs. pressure is allowed to expand to ten times its bulk, *i.e.*, to 100 lbs. on the inch, before it is admitted to the working cylinder. This large loss would be still further increased in practice, as the average pressure at which the air would act on the piston would be considerably lessened by the throttle-valve. Where the value of the system depends altogether upon the amount of available energy which it is possible to store up, it is of the first importance to lose none of it.

TABLE.—Showing Amount of Power Stored, and Loss from the use of a Reducing Valve.

Pressure above the Atmosphere in lbs. per square inch.	Ratio of Expansion.	Hyp. Log.	Mean Pressure during the stroke.	Horse Power in 1 Cubic Foot of Air.	Horse Power in 1 Cubic Foot of Air at 1,000 lbs., when wire-drawn to	Per-centage of Loss from Wire-drawing from 1,000 lbs.
1,000	67·66	4,214,494	48·22	14·23	14·23	...
900	61·	4,110,720	46·66	12·41	13·75	3·5
800	54·33	3,995,073	44·92	10·67	13·27	6·8
700	47·66	3,864,090	42·96	8·93	12·67	11·0
600	41·	3,713,571	40·70	7·28	12·	15 0
500	34·33	3,536,017	38·04	5·69	11·31	22·6
400	27·66	3,319,984	34·79	4·19	10·24	28·1
300	21·	3,044,519	30·66	2·80	9·02	36·7
200	14·33	2,662,352	24·94	1·43	6·87	51·8
100	7·66	2,036,049	15·56	0·52	4·53	68·1

It appeared to me absolutely essential, before compressed air could come into practical use, that some construction of engine should be designed which would avoid the great loss which wire-drawing from high pressures would entail. The modern practical steam engineers recognise the desirability of this; and if it is necessary where steam is used, it is infinitely more so in the case of air where the fluid is more costly, and the loss from wire-drawing greater in proportion to the increased difference between the reservoir and boiler pressures respectively, and those in the cylinders.

The curve shown in the diagram expresses graphically the available power at different pressures dan the loss from wire-drawing. The difference between an engine working with or without complete expansion may be conveniently likened to the work done by a man on a treadmill, in the one case stepping directly on to the wheel from a high platform, and in the other, having mounted the platform, walking two-thirds of the way down again before putting his weight on the wheel.

I have before alluded to the results which my system has given, and the highest importance may fairly be claimed for them in special cases, such as for the working of underground railways, of tramways, and to supersede the employment of horses in mines. The entire average cost of working English tramways is, approximately, 12d. per mile run, while the receipts are 16d.—the difference, 4d., representing the interest available for dividend on the capital employed.

The Company now working my patents are willing to undertake the tracting of tramways at 6d. per tram mile, which corresponds to a saving of about 1d. per mile over horse traction, which costs, for two-horse cars, 7d. per tram mile. This saving will increase tramway dividends 25 per cent., irrespective of releasing the capital represented by the horses now employed, which would be sold. Moreover, a change from horse to mechanical traction is desirable, from a humanitarian point of view; the strain put on the tramway horses is most severe, owing to the weight to be started, and the inelastic character of the load, in bad weather and on inclined lines the condition of the horses is often pitiable.

In mining, too, the horses and ponies employed have by no means happy lives, stumbling along with a heavy train of tubs behind them—a false step may cause them to fall in front of the train—while the lights they are supposed to carry are frequently wanting; as they are so much out of sight, too, the tender mercies of their drivers are beyond public control. Any system of air locomotion would be an unmitigated blessing to that portion of the brute creation which is employed underground.

The Channel tunnel scheme, now that the works have actually commenced, is attracting great public attention, and it is hardly too strong a statement to make, without air locomotives the tunnel could neither be constructed in any reasonable time, nor properly worked when made.

The most difficult problem in connection with its construction is how to remove through a single small opening the *deblais*, and introduce the men and material necessary for the completion of the work, the working faces being perhaps miles from the entrance.

No system of traction by horses could answer, as its speed would be confined to three miles an hour. Ropes would be impossible, as the termini of the trains would be continually varying in position. No amount of artificial ventilation would enable steam locomotives to be used. The air locomotive, however, not only overcomes all these difficulties, but it actually improves the ventilation. In working the permanent traffic, taking the gross weight of the train to be 200 tons, this would require 70 cubic feet of air per train mile, or say 1,400 feet to do the 20 miles between the French and English coasts. A 60-ton engine could carry this amount easily; there would, however, be not the least difficulty in having an air main permanently charged, extending the length of the tunnel, from which, in the event of the necessity arising, an engine could obtain the supply of force needed.

As regards the Underground Railway, the trials recently made show the perfect practicability of working the traffic by compressed air. Its adoption resolving itself entirely into one of cost, and while

the working expenses cannot vary much one way or the other if air be substituted for steam, no doubt a heavy first outlay would have to be incurred for plant. The public papers teem with contributions and articles on the injurious effects to health from the bad gases and defective ventilation on the line. It rests with the public to judge whether they will be willing, should it be necessary, to pay a little more for their tickets and enjoy the luxury of fresh air. My own impression is that the cost to the railway would be more than counterbalanced by the gain, but at the very outside the loss (if loss it were) would be covered by a small increase in the fares. The science of storing power on a large scale is only in its infancy; an enormous field is opened, if only it is found practicable, to manufacture energy at fixed centres, supplying the power of locomotion ready for use. I have no doubt that compressed air has a very great future before it, and those who are first in the field will be the first to reap the benefits arising from its use.

DISCUSSION.

The Chairman said they must feel indebted to Colonel Beaumont for this new invention of his, which seemed calculated in the future to occupy a very prominent position. It was no longer an hypothetical scheme, having been practically tried at Woolwich, on the South-Eastern Railway, and on the Metropolitan Railway, in actual work; and it had since been tried on the tramway which was about to adopt it. It appeared to him that the main principle consisted in using heat in combination with the pressure of air; for, as they knew, simple compressed air had been tried before, but had never succeeded in any practical way. Colonel Beaumont, however, appeared to have solved the difficulty by jacketting the cylinders, by which means he obtained greater elasticity in the air, and a great saving in the use of it. This seemed very simple, but all great inventions were simple. He could not enter into the mechanical construction of the engine, which was not immediately before them, but its advantages appeared to be very great, especially in the case of tramways. He did not think tramways were likely to compete injuriously with railways, but they might be made very valuable as auxiliaries and feeders to them; and this invention was specially calculated to assist that movement. In the country you often stopped at a station which was two or three miles from the town you wanted to go to, and if the railway companies were to promote tramways in such situations where it would not pay to make a regular railway, the amount of traffic which would be developed would be very considerable. There were many difficulties connected with the use of horse-power; horses required feeding, grooming, and stables; they got ill, and sometimes died; whereas an air-engine was free from all these drawbacks. Once provided, all you had to do was to fill it with air by means of a steam-engine, and you had an engine of enormous power entirely under control by which you could convey a considerable load ten or twelve miles with ease. The only question was the cost of the engine for compressing the air, which compression could, no doubt, in some cases, be effected by the use of wind or water power.

Mr. Liggins remarked that all who travelled by the Underground Railway would be grateful for the abolition of the evils of smoke, noise, and bad odours which they had to endure on that most useful route. Air was one of the elements given for our use, and it was for human ingenuity to devise means for utilising it. Colonel Beaumont had practically shown how it might be used, and no doubt many ingenious men would soon be turning their attention to the improvement of this apparently simple but most useful apparatus. He would suggest that the heat required around the cylinder might be obtained by the use of liquid fuel—a subject which had been for some years before the Institute of Naval Architects, and thus the necessity for having a stoker would be avoided. This saving effected on the Underground Railway might go a good way towards the cost of providing the stationary engines for compressing the air.

Mr. G. Stevenson said that two of the Mekarski detached air-engines were placed on the Wantage tramway in July last, and continued to work the passenger traffic of the line between the town and the Great Western Railway Station at Wantage-road until the following October, the pumping station for supplying the engines with compressed air having previously been set upon a piece of ground in the tramway station-yard at the Wantage end of the line. The engines ran on ordinary days four journeys, each to and from the town to the station, and on market days and special occasions five journeys each, often taking two loaded cars up and down. No goods traffic was conveyed by them, but a trial was made on a portion of the line with a heavy truck-load of coals, which one of them moved with ease up a gradient of 1 in 44. The distance travelled over by each engine without a fresh charge of air was, as nearly as possible, five miles, and the quantity of air required for propulsion varied according to circumstances, but generally exhausted about 70 per cent. of the quantity stored in the engine and car for the service. The apparatus connected with each engine for carrying the supply of air for the journey consisted of four strong steel clyindrical vessels, three of which formed the battery, and one the reserve. The air at starting was compressed into these containers up to 30 atmospheres, or 650 lbs. to the inch. After the journey, the pressure generally ran down to about 5 atmospheres in the battery, and 27 atmospheres in the reserve. The air, before passing into the cylinders, was expanded by being forced through hot water at a temperature of about 300° Fahr., which gave it additional moisture, and acted as a lubricant to the cylinders; the pressure at which the air was supplied to the cylinders varied according to the propelling power required, but seldom exceeded 70 lbs. to the inch. The speed at which the engines travelled on the line averaged about nine miles an hour, but from the pressure available, it was clear almost any reasonable speed could be easily attained by them. The smoothness and freedom from clatter, hissing, and noise of every description, was very great, and on no occasion did he observe the slightest appearance of vapour, steam or, smoke, either from the cylinders or the exhaust, and he was not aware of any horse having been frightened the whole time the engines were running. He was not able to ascertain the cost of producing the air for the propulsion of the cars per mile by the Mekarski air-engines, as the air-engine company worked the traffic for three months at their own expense, but as far as he could learn, it took about 24 cwt. of coals per day to produce the power necessary for propelling the cars. He did not consider, in this respect, that anything like the best results of compressing the air were obtained, as the boiler used for the purpose of working the compressing engines appeared unsuitable, and swallowed up an extravagant quantity of fuel, and the whole apparatus was too ponderous for the small amount of work that had to be done. With the simple exception of the cost of working (which, at present, appears to be in excess of steam, although less than horse power), he knew of of no motive power so free from imperfection, and so fully under control, as compressed air for tramway and railway lines, as well as for a great variety of other purposes, where a clean and noiseless motive power is required.

Mr. Francis Cobb asked what were the gradients on which the engine had worked, with a train behind it. Some of the gradients on the section of the Metropolitan line, as shown on the diagram, appeared to be as high as 35°.

Colonel Beaumont said the section was exaggerated. The steepest gradient he had worked on the Metropolitan Railway was 1 in 75. The steepest on the line, he believed, was near Snow-hill, where, for a short distance, it was 1 in 40; but the steepest he had taken the engine over was from Praed-street to Edgware-road, which was about 1 in 70 or 75. The steepest tramway gradient he had worked was 1 in 13 at Leeds, in Cooperage-street. There was nothing in the use of compressed air which assisted an engine to mount a gradient, or the reverse, as compared with steam. Steam or air could only supply the motive powers to the wheels, and if the wheels refused to grip, the engine and its load must remain at the bottom of the hill. But there was one point in which it seemed to him that compressed air had a great advantage. If you had a detached engine, and it had to work up steep gradients, such as 1 in 15, or 1 in 18, similar to those which often occurred in tramways, as in the case of the North Staffordshire, you could not get an engine to mount such an incline with a reasonable load behind it, unless it had a weight of about 13 tons, which meant that that weight had to be dragged over the whole line in order to get over the difficulty of that single gradient. Now this difficulty was removed if you could combine the engine and the car. The difficulty of doing this in the case of steam was very great, but with compressed air there was no difficulty whatever, as the reservoirs could be carried on the top of the car, or under the seats. The remarks just made on the Wantage tramways had a very important significance, because they showed that instead of compressed air being ridiculed as a motive power, as was the case a few years ago, it was creeping into public favour, and there was a growing opinion that it was one of the coming powers of the future. The result of the trial made at Wantage, and it was only a trial, showed that compressed air answered all the purposes required of it, and that was an enormous step forward. The only objection was, that Mekarski gave no satisfactory information as to the cost. Now, it was exactly on that point, having seen what the Mekarski engine did in Paris and elsewhere, that he took up the question; and he saw that compressed air could only be used advantageously by avoiding the enormous loss shown in the diagram to arise from reducing the pressure, and supplying the necessary amount of heat by steam-jacketting the cylinder, which were really the alpha and omega of his improvements in the application of compressed air.

Mr. C. B. King said it was not quite correct to state, with regard to the North Staffordshire tramways, that it required an engine weighing 13 tons to get up the incline. It was done with a steam locomotive weighing only 9 tons.*

Colonel Beaumont said his information was derived from the experience of Messrs. Manning and Wardle, who put on an engine which, he believed, weighed 12 tons empty; at any rate, he was within the mark in saying 10 tons empty, and he contended that that was far too heavy a weight to put on any tramway line.

Mr. Bodmer said the theoretical advantages of Colonel Beaumont's system, over those in which reducing valves were used, must be conceded, but the difficulty which at once occurred to an engineer was, how, with such high pressures, were leakages to be avoided, and he should like to have this explained.

Mr. Haughton congratulated Colonel Beaumont on the way in which he had compressed his paper, but whilst complimenting him on its construction, must say, he should have liked to hear a little more about the construction of the engine. He should like to know how this enormous pressure was dealt with, and also whether there would be any difficulty in dealing with still greater pressures. If these enormous pressures could be satisfactorily utilised in every-day work, we should gain advantages we had never hitherto enjoyed; for if air could be compressed to a pressure of 1,000 or 2,000 lbs. to the square inch, or even perhaps more, there would be an enormous gain of power. The peculiarity of this engine seemed to be the introduction of air at an enormous pressure, and the communication by external means the heat necessary to enable it to expand, thus utilising the power contained within it. If the engine worked satisfactorily, and it seemed to have done so, and would continue to work satisfactorily, there was a very great future before it, for it was evident that certain railways could only be worked by this or one or two other means. Take, for instance, the Channel tunnel: they had all had practical experience of the defects of ventilation on the Underground Railway, and it was therefore obvious that, with a tunnel 22 miles in length, the atmosphere would be absolutely pestilential from the products of combustion if steam were used. For the tunnel to be a success, it must be worked either by the pneumatic system—a gale of wind behind the train, or by some compressed air system, or, lastly, by an electric railway, such as was now about being tried in New York. He should be glad to know whether these high pressures could be indefinitely utilised, and, further, what was the precise amount of duty per lb. of coal obtained during the use of compressed air.

Mr. Perrett, whilst wishing Colonel Beaumont every success, feared that his views as to the application of his system to tramways were rather too sanguine. He had stated the traction at 25 lbs. to the ton, and that might be so where the tramway was new and good, and the road clean, but from some practical experience, he knew that 45 lbs. to 50 lbs. would be nearer the mark as an average, and, therefore, half the power was gone at once. His calculations referred to a practically level line; and it would be the same thing where the gradients did not exceed 1 in 100 or 1 in 80, because what you lost in going up hill would be gained in going down; but with anything beyond that you required an excess of power in going up, and to put on the breaks going down. On the majority of level tramways, the companies were satisfied with horses, but they wanted mechanical power to work them up over steep places; but for such places, it seemed to him that compressed air was satisfactory. He had in his mind two towns, one of which had an average gradient of 1 in 34, rising in some places to 1 in 17, for 4,000 yards. In that place they were very anxious to have some mechanical power, but if horses could do the work, he, though an engineer, must confess he should prefer them to any mechanical arrangement, if it could be done for the same money. To his mind, it depended far more on the simplicity of the engine and on the absence of repairs than on anything else. The cost of repairs with steam was enormous compared to any other item, even that of fuel. If coals cost ½d. or ¾d. a mile, repairs would cost 2d. and 2½d. In fact, the driver's wages came to more than the coal. Again, the efficiency of this new engine seemed to depend on having a small boiler attached to it, but for his part he should much prefer it if this could be dispensed with. Compressed air had many advantages, but it must be compared with the steam-engine of the present day, not with what it was some years ago.

Colonel Beaumont, in reply, said that with regard to the question of leakage, any leakage in the reservoir would be fatal, but they were able now to make

* The gradients upon the North Staffordshire Tramway are exceptionally heavy, ranging from 1 in 12 (for 125 feet) to 1 in 88 (for 1,934 feet).

reservoirs absolutely bottle tight, with no leakage whatever. His No. 2 engine was pumped up when it was tried at the Victoria Docks; about 300 lbs. pressure was left in it about Christmas, and a sufficient amount of power was left in it to move the engine only a week ago. As to the provisions necessary to prevent leakage in the pistons, he could not go into the details in such a meeting, without drawings and diagrams, but the principle was similar to that employed by Perkins for his high pressure steam-engine. The leakage was stopped by having a series of rings, which acted as bafflers to the air, and made the piston all but tight. Assuming that it was not absolutly tight, it would be remembered that the second cylinder took up any leakage from the first, and he did not believe—although it was impossible without indicator diagrams to say that it was so—that any serious loss from leakage occurred. As to wear and tear, the engine which was tried on the Underground Railway remained, so far as its valves, adjustments and details, were concerned, precisely in the same condition as it left the makers' yard about a year ago, after having done, not continuous work, because there had not been the opportunity for that, but having run a good many hundred miles, and required absolutely no repairs at all. He thought, in using these high pressures, loss by wear and tear would be diminished rather than increased. The engine must be powerful when it could pull a Metropolitan locomotive weighing 40 tons, but when it was running 15 miles an hour the motion of the valves admitting the air was so small as to be scarcely perceptible, and the valves by which the high pressure air was admitted were hardly as big as the top of a pencil. The force stored in the air at this high pressure was so great that it required a very small consumption of air. At the same time, while perfectly safe to use, if proper precautions were taken, it was no doubt dangerous without proper precaution. To see that his valves were absolutely tight, he had a valve made which worked by means of an excentric in the builder's yard, which was kept running for two or three days, simply cutting off and admitting air. When the valve was not at work it was absolutely tight, so that you could with safety put your eye to it, and look up the valve; but the instant it was lifted the very least, the air at this high pressure coming out exerted so great a force, that it would not only tear a piece of paper to pieces, but if you put your hand underneath it would tear the flesh off your bones. Yet after the length of time these valves had been at work, he had not been able to detect the slightest wear, tear, or deficiency in the engine. One gentleman had asked for further mechanical details, but, for the reasons he had given, it was impossible to go into that; but he might say, that after the air had passed the high pressure cylinders, there was no difference in principle between his engine and an ordinary piece of machinery. It had also been asked if it would be practicable to use air at a pressure of 1,500 or 2,000 lbs. on the inch. In his judgment, that opened a new and most important field, which, by degrees, he was hoping to occupy. He had known air to be compressed to 15,000 lbs. on the square inch; that was done by a gentleman at Manchester, his object being to supersede the use of powder for blasting in mines. He was turning his attention in this direction; but finding this had been done, he at once abandoned it, as another gentleman had occupied the ground before him. He did not think, however, that the way in which it was being applied was perfectly practicable, and he was now in commuuication with some people to see if some means could be found, by which the use of compressed air could be substituted for dangerous explosives in mines. It was quite simple to compress air up to 15,000 lbs. to the inch, but when you came to use it again, no doubt a variety of difficulties would arise. He would say, however, that ere long a pressure of 1,000 lbs., instead of being considered anything enormous, would be looked upon as a reasonable pressure. For tramway and similar purposes, if you could go a distance of 10 miles with a single charge, there was no great object in going to a higher pressure, but in other cases it would be necessary. It had been suggested to him several times to make a compressed air tricycle, and he intended to try it. He thought it could be done, but, in dealing with these very high pressures, you had to deal with forces which a steam-engine had not to contend with, and consequently when he put the matter into a draftsman's hands, he brought out designs which were incompatible with the light form which a tricycle must take. At the same time he believed it was possible to make a tricycle which should go three miles without recharging, but the solution of the problem depended on the possibility of constructing an engine to work at a pressure of say 2,000 lbs., and which should lose no power by the use of a reducing valve. With regard to the amount of coal needed, the figures would be found in the paper, and that was an all important point with regard to the application of compressed air to tramways. The results of the trials already made were all summed up in the statement that one cubic foot of compressed air would take three tons one mile on a railway; and, with proper arrangements, $\frac{3}{4}$ lb. of coal would compress one cubic foot of air to 66 atmospheres. Consequently, $\frac{1}{4}$ lb. of coal consumed under the boilers of a properly constructed compressing engine would take one ton of mile, which about corresponded to the average duty a coal in a locomotive. It might be said, if that was the case, there would be an end of ordinary locomotives, but that did not follow, because a variety of other considerations came in, especially the extra cost of plant. The Underground Railway could probably be run at about the same working cost, but it would require an increase of 50 per cent. in the value of the plant, and the bulk of the present plant would be rendered useless. Mr. Perrett said he would sooner see the work of tramways done by horses than engines, but in winter, and bad weather especially, the horses had a very hard time of it, and, therefore, he should have rather expected an engineer to say that he would prefer to see the horses doing some other kind of work. But that point did not really concern an engineer; because he was quite certain that no system of mechanical traction had any chance of superseding horse-power unless it showed a saving. In that view the offer he was prepared to make was to take any tram line and tract it at 6d. per mile, instead of 7d., which represented the average cost of horse traction, as would be seen by an examination of the accounts of the North Metropolitan Tramway Company. That would show a saving of 1d. a mile, which would add 25 per cent. to the profits. The same gentleman seemed to think there was a difficulty about a compressed air-engine mounting steep gradients, and, if that were the case, any engineer would be a lunatic to think of introducing it; but the fact was, of all lines he should prefer to work with compressed air, would be one with a steep gradient; because the cost of horse flesh increased in proportion to the gradient, and so did the difficulty of working with a steam locomotive; simply because the boiler was tipped up at an angle, and, consequently, laid bare the tubes. They all knew the danger and difficulty which attended any portion of the tubes of a locomotive getting burned, because the cost of it depend principally on keeping the boiler in repair. This was so important that, in some cases, where steep gradients had to be encountered, a vertical boiler was used, but that was always an unsatisfactory arrangement. Another difficulty was that it was quite impossible for a steam locomotive to proportion its weight to the work it had to do. The boiler had to be capable of supplying the cylinders with steam, in proportion to whatever the maximum draw might be, and the maximum draw depended on the maximum incline

the engine had to ascend. With compressed air this difficulty did not arise. You could run up an incline of 1 in 14, with a comparatively small supply of air in the reservoir, because you could take in a fresh supply either at the bottom or the top of the incline. Consequently, if you were working a tramway line, where the incline for a short distance was very severe, it would need no special arrangement beyond a provision at the bottom of the incline for giving the engine a fresh supply of air.

The **Chairman** then proposed a vote of thanks to Colonel Beaumont for his interesting paper, which was carried unanimously.

MISCELLANEOUS.

A NEW TELEPHONE.

A paper "On the Conversion of Radiant Energy into Sonorous Vibrations," was read before the Royal Society last week, by Mr. W. H. Preece, the electrician to the Post-office. The remarkable discovery of Messrs. Graham Bell and Sumner Tainter that the rapid intermittent incidence of rays of light on discs of hard substances produces sonorous vibrations has attracted very much attention, and has excited much physical work to solve an unexpected problem. The advocates of the emission theory of light have striven for 200 years to obtain such a proof of their theory and have failed. Why have Bell and Tainter succeeded, or have they succeeded at all? May not their phenomena be due to some other cause than to the incidence of light? It was suspected by many that it was a heat effect, and not a light one at all. M. Mercadier, in Paris (Comptes Rendus, Dec. 6th, 1880), and Professor Tyndall (Proc. R.S., Jan. 3rd, 1881) have placed this beyond the region of doubt, and now Mr. Preece has completed the chain of evidence by a careful and elaborate inquiry into the cause of the phenomena. In the first part of his paper he has shown that ebonite and india-rubber, though opaque to the light rays, are remarkably diathermanous or transparent to the heat rays, and therefore that radiant heat can act through screens of those materials. Indeed, ebonite is shown to be almost perfectly transparent to radiant heat, while it is absolutely impervious to light. He next shows by experiments made on very delicate apparatus that no more vibrations than six per second can possibly be produced by the direct impact of heat waves causing expansion of the mass of the disc, and therefore that the Bell-Tainter effect is not due to the absorption of heat changing the volume of the hard substance experimented upon. He next inquires whether the effect observed is due to a molecular pressure similar to that which produces the rotation of the radiometer, for this being a mere surface action, the element of time is eliminated. Many experiments are described which were made with discs of various kinds in different ways, but the results were so unsatisfactory and variable that the question was raised whether the discs vibrated at all. By the aid of microphones and specially constructed chambers, it is proved clearly that the undulations are those of the contained air, and not of the discs. In fact, the sounds were intensified by removing the discs. Moreover, the effects were materially assisted by coating the sides of the containing vessel with a substance highly absorbent of heat, such as the carbon deposited by burning camphor. It is next shown that the effects are dependent on the number of heat rays that pass through the discs, and not on those that are incident on them, and that the greater the absorbent character of the air or vapour contained in the case, the more intense the sounds emitted. All these results are repeated and shown with ordinary flasks lampblacked on their exterior and interior. Finally it is shown that there is a time element introduced, and that the loudness of the note emitted depends not only on the rapidity with which the contained air absorbs the radiant energy, but also on the rapidity with which it gives up its heat to the sides of the case and the exits open to it. It varies also with the form of the enclosed space, and with the character of the contained vapour, and with the diathermancy only of the discs. The effect being thus due to radiant heat, and its absorption by suitable surfaces, it was next shown that if a spiral of wire be completely enclosed in a lamp-blacked case, sounds were emitted when currents of electricity were rapidly and intermittently transmitted through the wire, and, moreover, that when these currents were produced by a proper microphone transmitter, articulate speech was reproduced. Hence these phenomena are simply effects of radiant heat, and they are due to the changes of volume in absorbent gases and vapours, produced by the absorption of thermometric heat in a confined space. All the varied and novel experiments which Mr. Graham Bell performed when he was recently in Europe with solids, liquids, and gases, with tubes, flasks, and discs, are thus brought within one simple explanation, and are due to a remarkable influence of degraded heat rays on absorbent vapours. The final result of this inquiry has been, not only to unravel an exceedingly interesting scientific problem, but to produce another form of telephone, based on a new principle.—*The Times*.

LUMINOUS PAINT.

The manufacture of this paint, which was first brought prominently into public notice by Mr. Heaton's paper upon it last year (*Journal of the Society of Arts*, vol. xxviii., p. 389), is stated to be progressing satisfactorily, the manufacturers having succeeded in considerably reducing the cost of production, and consequently the cost at which the article can be commercially supplied. One of the more important of recent applications of this material is for the white-washing of ceilings. When the paint was first made, it was proposed to utilise it in this manner, but one difficulty in doing so was the high cost of the material, and the second was that it could only be applied with a varnish, and not in the ordinary manner of a lime wash. There seems, however, now to be no difficulty in this application, and several small rooms have been successfully treated. Mr. Spottiswoode, the President of the Royal Society, has had the ceilings of some rooms in his house covered with this paint, and at the company's offices in Aldermanbury there is also a room with a luminous ceiling. The effect is better than might have been anticipated. The room appears as if it were lighted with bright moonlight, except that no portion of it is brighter than the rest, as is, of course, with moonlight, where the rays of the moon actually fall. Even on coming into such a room out of the daylight there is no difficulty in seeing sufficiently well to walk about the room, take papers or objects from the table, &c., and after a few minutes the eyes become sufficiently accustomed to the light to be able, at all events, to see the time by an ordinary watch face. Another novel application is to portable lanterns, if such an expression can be used. These are formed of oblong tin cases, the outside of them being coated with the paint. Upon hot water being poured into the inside, the luminosity of the paint is excited to a very high degree. It is well known to those who have experimented with the material that on lighting a surface covered with it by magnesium wire or other powerful illuminator, the great brilliance which immediately results dies down in a very short time, leaving a comparatively dimly-lighted surface. The heat of the water brings out the same amount of brilliancy, and

keeps it at its maximum as long as the water remains hot. If only a little water be placed at the bottom of the tin, the luminosity may be aroused by shaking the tin, so as to warm all sides of it. As it dies down another shake brings it up again. This form appears much better than the ordinary plan of having a sheet of the stuff covered with a glass and set in a frame like that of a picture. These appear to be the principal applications besides those noticed in Mr. Heaton's paper above referred to. The paint is also used to a considerable extent for coating match-boxes, statues, brackets, &c., but such objects as these can only be included in the class of interesting scientific toys.

CORRESPONDENCE.

BRITISH RULE IN INDIA.

As I had not an opportunity of being present at Mr. Maclean's interesting lecture on "The Results of British Rule in India," I trust you will allow me to make some remarks on one branch of his subject, which seems to me to require further investigation—the question as to whether there is, or is not, danger in the future from over-population in India.

In the first place, Mr. Maclean compares the numbers of the population per square mile in India with the populations of other countries, and shows that, whereas India has 211 to the square mile, Belgium has 451; England and Wales, 389; Tuscany, 377; the Netherlands, 291; China, 289; Great Britain and Ireland, 265; Wurtemberg, 249; and Germany, 193. This is, no doubt, a useful comparison as far as it goes, but it really goes no farther than the edge of the subject. To complete it I would suggest to Mr. Maclean that it would be most important to give your readers the following information as regards each country:—

1. The population in each country depending on agriculture for subsistence.
2. A statement of the agricultural condition and prospects, showing especially whether the people have, or have not, the means of maintaining the fertility of the soil.
3. An account of the probable rate of increase of the population.
4. An estimate of the culturable unoccupied lands.
5. The character of the population, and whether it is of an emigrating tendency.

To show how necessary further investigation is, I may mention that, as regards the first point, I once had occasion, when writing on the danger of over-population, to compare India with Belgium. I then found that the agricultural population of India exceeds that of Belgium, while, taking into consideration the vast waste area of India, I found the agricultural population of India to the square mile so much exceeding twice the agricultural population of Belgium, that it certainly seemed to me to be quite safe to say that the agricultural population of India is, to the available square mile, already double that of Belgium. In other words, whereas Belgium, from the bare statements of statistics, would appear to have twice the pressure of population that India has, the latter country has practically a pressure of about double that of Belgium; and I feel quite sure that, if the other points I have mentioned were carefully considered, the danger of over-population in India is incomparably greater than would, at first sight, naturally be supposed.

But Mr. Maclean has another test, though by his way of stating it, it would seem to be the only one needed. "The whole controversy," he says, "about over-population, resolves itself into the question—Are the rates of wages relatively higher or lower in proportion to the prices of food grain, than they were ten or twenty years ago?" Is not this, to say the least of it, a singular way of attempting to solve, or, I should perhaps rather say, shelve a most difficult problem? Let us, for the sake of argument, admit that the rates of wages in India are universally relatively higher in proportion to the prices of food grain than they were ten or twenty years ago, and let us ask what then? It is proverbially difficult to prove a negative, and Mr. Maclean has thrown upon himself the task of proving a most formidable negative. He must prove that the material increase of the population will not ultimately destroy his test; in other words, will not have the effect of again lowering the rate of wages relatively to the price of food, down to the rates which prevailed ten or twenty years ago.

Let me notice another of Mr. Maclean's conclusions. He thinks that because the Bengali refuses to emigrate, he must therefore be, "on the whole, tolerable well-satisfied with his lot." Are the Irish cotters, in the west of Ireland, tolerably well-satisfied with their lots, because they are disinclined to emigrate? I am afraid that this statement will no more bear examination than one to be met with some sentences further on, where Mr. Maclean informs us that the "English labourer, earning his twelve to eight shillings a week, is compelled to live on animal food and strong drink." I have no doubt that he only wishes he was put under any such compulsion, and that his wage were high enough to admit of his living so luxuriantly.

ROBERT H. ELLIOT.

Clifton-park, Kelso, N.B.

GENERAL NOTES.

International Wool Exhibition at the Crystal Palace.—In connection with this Exhibition, the Clothworkers' Company offer the Company's Gold Medal for the following subjects:—(1) For the best piece-dyed Navy blue cloth or worsted coating; (2) for the best Navy blue cloth or worsted coating, dyed without the use of indigo; (3) for the best scarlet cloth, dyed without the use of cochineal; (4) for the best 10-lb. sample of scarlet woollen yarn, used for shirtings, dyed without the use of cochineal; (5) for the best piece of bleached flannel, the bleaching to have been affected without the use of sulphuric acid in any form; also for various articles composed entirely of English wool (*i.e.*, wool grown in Great Britain and Ireland), and for the best apparatus for scouring and cleansing worsted coatings, previous to dyeing. Preference will be given to that which most thoroughly combines efficiency with simplicity and economy in working. The Drapers' Company have voted a sum for various special prizes, and other of the City Companies identified with the textile industries propose doing the same; these are in addition to the medals and certificates to be given by the Directors of the Crystal Palace Company.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

MARCH 23.—"The Increasing Number of Deaths from Explosions, with an Examination of the Causes." By CORNELIUS WALFORD, F.S.S. Professor ABEL, F.R.S., will preside.

MARCH 30.—"Recent Advances in Electric Lighting." By W. H. PREECE., M.Inst.C.E. C. W. SIEMENS, F.R.S., will preside.

APRIL 6.—"The Discrimination and Artistic Use of Precious Stones." By Professor A. H. CHURCH, F.C.S. Sir PHILIP CUNLIFFE-OWEN, K.C.M.G., C.B., C.I.E., will preside.

APRIL 27.—"Five Years' Experience of the Working of the Trade Marks' Registration Acts." By EDMUND JOHNSON.

Dates not yet fixed:—

"The Manufacture of Glass for Decorative Purposes." By H. J. POWELL (Whitefriars Glass Works).

"Buying and Selling; its Nature and its Tools." By Professor BONAMY PRICE, M.A. Lord ALFRED S. CHURCHILL will preside.

"The Electrical Railway, and the Transmission of Power by Electricity." By ALEXANDER SIEMENS.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at eight o'clock:—

APRIL 5.—"Canada; the Old Colony and the New Dominion." By E. HEPPLE HALL.

MAY 10.—"Trade Relations between Great Britain and her Dependencies." By WILLIAM WESTGARTH.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings, at eight o'clock:—

MARCH 24.—"The Future Development of Electrical Appliances." By Prof. JOHN PERRY. LATIMER CLARK, F.R.G.S., will preside.

MAY 12.—"Recent Progress in the Manufacture and Applications of Steel." By Professor A. K. HUNTINGTON.

INDIAN SECTION.

Friday evenings, at eight o'clock:—

MARCH 25.—"The Tenure and Cultivation of Land in India." By Sir GEORGE CAMPBELL, K.C.S.I., M.P. ANDREW CASSELS, Member of Council, will preside.

MAY 13.—"Burmah." By General Sir ARTHUR PHAYRE, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

CANTOR LECTURES.

Monday evenings, at eight o'clock:—

The Third Course will be on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. ADAMS, F.R.S. Four Lectures.

Syllabus of the Course.

LECTURE III.—MARCH 21.

Use of magneto- and dynamo-electric machines for electric lighting. Electric lighting by means of the arc.

LECTURE IV.—MARCH 28.

Subdivisions of the electric current. Incandescent lamps. Luminous effects of electric currents in a vacuum, and in various gases.

The Fourth Course will be on "The Art of Lace-making," by ALAN S. COLE. Four Lectures.

April 4, 11; May 2, 9.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. BRUDENELL CARTER, F.R.C.S. Three Lectures.

May 16, 23, 30.

ADMISSION TO MEETINGS.

Members have the right of attending all the Society's meetings and lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 21ST...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor W. G. Adams, "The Scientific Principles Involved in Electric Lighting." (Lecture III.)
Royal United Service Institution, Whitehall-yard, 8½ p.m. Vice-Admiral J. H. Selwyn, "A New System of Hydraulic Propulsion."
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Resumed discussion on Mr. H. H. Collins's paper, "Sanitation, as an important Increment of Value in House Property."
Medical, 11, Chandos-street, W., 8½ p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Paper by Mr. J. F. Bateman.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. R. Bentley, "Fungi."

TUESDAY, MARCH 22ND...Royal Institution, Albemarle-street, W., 3 p.m. Prof. E.A. Schäfer, "The Blood." (Lecture X.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. David Phillips, "The Comparative Endurance of Iron and Mild Steel when exposed to Corrosive Influences."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Prof. W. H. Flower, "Artificially Deformed Skulls from Mallekolo." 2. Mr. Joseph Lucas, "The Ethnological Bearings of the terms Gypsy, Zingaro, and Romo."
Royal Colonial, the Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Mr. W. M. Torrens, M.P., "Imperial and Colonial Partnership in Emigration."
Royal Horticultural, South Kensington, S.W., 1 p.m.

WEDNESDAY, MARCH 23RD...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. Cornelius Walford, "The Increasing Number of Deaths from Explosions, with an Examination of the Causes."
Geological, Burlington-house, W., 8 p.m. 1. Mr. C. Parkinson, "The Upper Greensands and Chloritic Marl of the Isle of Wight." 2. Mr. Clement Reid, "The Flow of an Ice-sheet, and its Connection with Glacial Phenomenon in Britain." 3. Dr. R. W. Coppinger, "Soilcap Motion."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. C. F. Keary, "The Genuine and the Spurious in the Eddaic Mythology. I. Myths of Death and of the Other World."
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Croonian Lectures.) "Influence of the Circulation upon the Nervous System." (Lecture I.)

THURSDAY, MARCH 24TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Prof. John Perry, "The Future Development of Electrical Appliances."
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. Ernst Pauer, "The History of the 'Suite.'" (Illustrated Musical Lecture.)
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. H. Statham, "Ornament Historically and Critically Considered." (Lecture II.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

FRIDAY, MARCH 25TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Sir George Campbell, "The Tenure and Cultivation of Land in India."
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Croonian Lectures.) "Influence of the Circulation upon the Nervous System." (Lecture II.)
Royal United Service Institution, Whitehall-yard, 3 p.m. Lieut.-Col. Lonsdale A. H. Hale, "Outposts, illustrated by the Systems followed in Continental Armies."
Royal Institution, Albemarle-street, W., 9 p.m. Mr. A. Buchan, "The Weather and the Health of London."
Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. J. G. Waller, "*Cliona celata*—Does the Sponge make the Burrows?"
Clinical, 53, Berners-street, W., 8½ p.m.

SATURDAY, MARCH 26TH...Ladies' Sanitary Association (at the HOUSE OF THE SOCIETY OF ARTS), 5½ p.m. Dr. B. W. Richardson, "Domestic Sanitation or Health at Home." (Lecture VI.)
Physical, Science Schools, South Kensington, S.W., 3 p.m.
Geologists' Association, University College, W.C., 2½ p.m. Visit to the Museum of Practical Geology, Jermyn-street, under the direction of Mr. Frank Rutley.
Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Rev. H. R. Haweis, "American Humorists." (Lecture II.)

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FRIDAY, MARCH 25, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third lecture of the third course was delivered on Monday, 21st inst., by Professor W. G. Adams, F.R.S., on "The Scientific Principles involved in Electric Lighting." The lecturer described the use of magneto- and dynamo-electric machines for electric lighting, and electric lighting by means of the arc. The lecture was fully illustrated by apparatus and lamps kindly lent by the following :—Mr. Berly, Jamin candles ; The British Electric Light Company, two Gramme machines, Brockie lamp, and Serrin lamp ; Brush Electric Light Company, Brush lamp; Mr. Latimer Clark, Lontin lamp, Wilde lamp, and models ; Mr. Crompton, Bürgin machine and armature, and Crompton lamp ; Messrs. Elliott and Co., Trowbridge's electro-dynamometer ; Messrs. Robey and Co., of Lincoln, a ten-horse power steam engine ; Dr. Siemens, F.R.S., early dynamo machine, pendulum lamp, electro-dynamometer and exploder ; Société Generale d'Electricité, Jablochkoff lamp. Diagrams were lent by Dr. Hopkinson, F.R.S., and Mr. Shoolbred. The lectures will be published during the summer vacation.

DOMESTIC ECONOMY CONGRESS.

A meeting of the General Committee was held on Tuesday, 22nd. Present :—Lord Alfred S. Churchill (in the chair), Miss Rose Adams, the Countess of Airlie, Mrs. G. C. T. Bartley, Lady Clive Bayley, Miss Clive Bayley, Miss Bidder, Mrs. Buckton, Miss Buckton, Lady Cole, Miss Cole, Miss King, Lady Dorothy Neville, Lady Arthur Russell, Miss Wetton ; Sir Henry Cole, K.C.B., Major-General Cotton, C.S.I., Rev. J. P. Faunthorpe, and Rev. Newton Price, with Mr. H. Trueman Wood, Secretary. The Committee considered and revised the Programme for the Congress.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1881, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows :—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially, by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts ; and for his improvement in the manufacture of iron ; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy, and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious manual labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal services rendered to Arts, Manufactures, and Commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

The Council invite members of the Society to forward to the Secretary, on or before the 23rd of April, the names of such men of high distinction as they may think worthy of this honour.

HOUSE SANITATION.

The Council offer the following Medals for the best Sanitary Arrangements in Houses built in the Metropolis, the plans of such arrangements to be exhibited in the Society's Rooms, Adelphi, in June, 1881, and to be sent in on or before 12th May, 1881:—

1. One Silver Medal for the best sanitary arrangements, carried out and in satisfactory working, in a house let out in tenements to artisans, for which a weekly rental is paid.

2. One Silver Medal for the best sanitary arrangements, in actual working, in a house of the yearly rental of £40, or less, to about £200 in value.

3. One Silver Medal for the best sanitary arrangements, in actual satisfactory working, in a house of the yearly rental value of £200 and upwards, to any amount.

4. The houses must be open to the inspection of the Judges, who, in considering their award, will be guided by the suggestions of plans for main sewerage, drainage, and water supply, made under the Public Health Act, 1875. The houses must have been in actual occupation within the last three months, and a Certificate must be given by the occupiers, on a printed form, stating the satisfactory working of all the sanitary arrangements, such form to be obtained at the Society of Arts.

5. The houses may be old, fitted with modern sanitary arrangements, or may be new. They must be within the metropolitan area of the Board of Works.

6. The sanitary arrangements must include the conditions for good water supply, drainage, warming, and ventilation of the house, and precautions taken against frost.

7. The medals may be awarded to the occupiers of the houses, or the lessees, or the owners.

8. The plans must consist of a ground plan and sections, to the scale of not less than one inch to five feet; details of not less than one inch to the foot. The plans may be accompanied by specifications.

9. The names of the architects, surveyors, or sanitary engineers who directed the sanitary arrangements should be given, and Certificates will be awarded to those whose plans obtain the Medals.

PROCEEDINGS OF THE SOCIETY.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 23rd, 1881; Professor F. A. Abel, C.B., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Atkinson, John, Tosti, Falsgrave, Scarborough.
Bacon, George Washington, F.R.G.S., 127, Strand, W.C.
Black, William, South Shields.
Lorimer, William, Messrs. Dübs and Co., Glasgow.
Russell, William J., Ph.D., F.R.S., 34, Upper Hamilton-terrace, N.W.

The following candidates were balloted for, and duly elected members of the Society:—

Appleby, Francis James, The Rowans, Lee-road, Lee, S.E.
Bayley, Sir Edward Clive, K.C.S.I., C.I.E., The Wilderness, Ascot.
Brass, John H., Wentworth-house, Manresa-road, Chelsea, S.W.
Brothers, William, Meadow-head-house, Livesey, Blackburn.
Cahen, Albert, 7, Bayswater-hill, W.
Godfrey, William Bernard, 54, Regent's-park-rd., N.W.
Jenkinson, Edward George, 26, Palace-gardens-terrace, Kensington, W.
Ogg, Surgeon-Major G. S. W., 8, Belsize-avenue, Hampstead, N.W.
Roper, Richard, 143, Lewisham High-road, New-cross, S.E.
Staight, Daniel George, 63, Tulse-hill, S.W.
White, Frederick Anthony, Kinross-house, Cromwell-road, S.W., and 85, Gracechurch-street, E.C.

The paper read was—

THE INCREASING NUMBER OF DEATHS FROM EXPLOSIONS, WITH AN EXAMINATION OF THE CAUSES.

By Cornelius Walford, F.I.A., F.S.S.,
Barrister-at-Law.

It should be fully understood, at starting, that I do not propose to approach this topic from a scientific point of view. Observations, conducted during a series of years mainly for statistical purposes, have impressed upon my mind the conviction that explosions are far more numerous and destructive than they have been at any previous period. This fact established, and the reasons thereof made plain, it will then remain for science to devise remedies in mitigation, or to declare why this cannot be done.

It is not necessary to seek far for the causes of the increased number of explosions in modern times. New forces are being constantly brought into play, to meet the requirements of our manufacturing and mineral industries. Steam itself, although we have ceased to regard its application as novel, is but a modern invention—regarded from the point of its practical application. It is, indeed, two centuries since the Marquis of Worcester described the steam-engine in his "Century of Inventions;" but it is very little more than one century since Watt's engine was first used as a motive power in a manufactory (1775); it is only during the present century that steam navigation has become a practical fact, and that steam has been employed for the purpose of locomotion on railways. One of the first fixed steam-engines erected in London was that used for the purpose of printing the *Times* newspaper, in 1814. The present generation may be said to have witnessed the general application of steam to our daily wants.

But, in truth, it is not so much to the effects of steam that we trace the increasing risk of explosion. Gunpowder has long played an important part, its use extending over some five or six centuries. Coal-gas, an invention falling within the range of the present century, has been, perhaps, on the whole, a more deadly agent of destruction—in the way of unintentional explosions—than gunpowder; while chemical compounds of almost endless variety, and, finally, mineral oils, make up the sum of the agents which in the present day prove so destructive to life and property.

In attempting to compare one period with another in the matter of destructiveness, we are in the position of requiring statistical records; for mere surmise is always more or less misleading, and is incapable of comparison in the sense of exactitude. There are practically no statistics available, prior to the returns resulting from the coming into force of the Act of 1836, for the registration of deaths. But this Act only applied to one section of the kingdom (England and Wales), and the detailed causes of deaths were not, as a matter of fact, published earlier than for the year 1838; and not then in such a manner as to be available for the purpose I now have in view.

Deaths Caused by Explosions.

In the third report of the Registrar-General, the deaths from explosions in certain selected districts, viz., the metropolis, Birmingham, Manchester and Salford, Liverpool and West Derby (adjoining), the mining districts, and the agricultural districts of Norfolk and Suffolk, were returned as being 41 in the year 1838, all occurring to males. The proportion of deaths from explosions, scalds, burns, and lightning (all classed together), to 100,000 deaths from all causes was found to vary in different districts of the kingdom from 14·6 in the metropolis to 20·7 in Norfolk and Suffolk; 28·3 in Manchester, Liverpool, and Birmingham, up to 38·8 in the mining districts.

In the seventh report of the Registrar-General, it is shown that the deaths from explosions, in the year 1840, were at the rate of 19·4 per million of the population, viz., males, 19; females, 4.

For the next 12 years, these national records are silent on the subject of deaths from explosion. This was not because the question was overlooked, but the rather that a process of elaboration was being devised, whereby the violent deaths in England and Wales should be rendered capable of scientific classification. The arrangement propounded in the nineteenth report was to classify the total violent deaths under six leading divisions. 1. Connected with railways; 2. Connected with mines (coal and metals treated separately); 3. Mechanical injuries; 4. Chemical injuries; 5. Asphyxia (suspension of respiration); 6. Violence not otherwise classed.

Several of these divisions enumerated deaths from explosions. The first from explosion of boilers; the second (in each of its sub-divisions), explosions of fire-damp, and also of boilers. The third, boiler explosions (very numerous); the fourth, explosions of chemical compounds. Thus, in the five years, 1852-6, the deaths from explosions were as follows, under the several causes mentioned by the Registrar:—

	Males.	Females.	Total.
1. Railways:—			
Explosion of Boiler	12	—	12
2. Mines (Coal):—			
Explosion of Fire-damp	988	1	989
,, Boiler	16	—	16
,, (Metal):—			
Explosion of Fire-damp	3	—	3
,, Boiler	6	—	6
3. Mechanical:—			
Explosion of Boiler	149	15	164
4. Chemical:—			
Explosion of Gunpowder	72	16	88
,, Camphine	—	1	1
,, Gases	27	2	29
,, Naphtha	7	—	7
,, Sulphur and Nitrate of Silver	24	—	24
Explosion of Fireworks	28	6	34
Here we have a total of	...	...	1,373

Giving an average of 274·6 deaths from explosions in England and Wales for each of the years embraced in the period under observation.

It now becomes possible to commence the construction of a table, showing the annual deaths from explosions in England and Wales, but not continuously, for the returns in a corresponding

shape to those last reviewed were omitted during the six years 1857-62, since which last date, however, they are continuous.

In the enumeration which recommenced in 1863, there were included some items which did not previously appear, as, for instance, under "Coal Mines," "Explosions of Sulphur," and "Explosions not stated how," these latter not including those resulting from "Blasting," which are separately stated, but are not included in my table; while under Chemical are added "Gun-cotton," "Petroleum," "Tar Boiler," "Manner not stated."

Table A.—Showing the Deaths from Explosions occurring during the period 1852–1879 (England and Wales).

Year.	Males.	Females.	Totals.	Bearing the proportion to the total violent deaths of the year, of 1 in
1852	290	6	296	48·9
1853	232	9	241	61·5
1854	297	12	309	49·1
1855	206	9	215	71·1
1856	307	5	312	47·8
1857	No returns —	—	—	—
1858	—	—	—	—
1859	—	—	—	—
1860	—	—	—	—
1861	—	—	—	—
1862	—	—	—	—
1863	266	12	278	56·4
1864	216	10	226	75·3
1865	164	8	172	101·0
1866	289	8	297	57·0
1867	590	12	602	28·0
1868	379	13	392	43·3
1869	407	18	425	38·8
1870	311	12	323	51·4
1871	258	73	331	51·3
1872	265	10	275	62·8
1873	171	18	189	91·2
1874	287	17	304	59·0
1875	242	22	264	71·5
1876	341	12	353	52·0
1877	131	13	144	122·8
1878	391	13	404	46·6
1879	450	12	462	38·2
	6,490	324	6,814	
Average of the 22 years	295·0	14·8	309·8	

It will be seen that there are considerable fluctuations in the annual number of deaths from explosions. This was to be expected, from the nature of the case, but they will be found mainly to arise from explosions of fire-damp in coal mines, with occasional fluctuations from other causes. In view of elucidating this point, I have prepared the following table, showing the annual deaths from the principal classes of explosions, as—1, fire-damp; 2, boiler explosions; 3, chemical explosions; 4, undefined causes (embracing both sexes). This at one glance gives an indication of the cause of fluctuation in any one year or at particular periods.

One or two of the more prominent cases of fluctuation, shown in Table B., may be made plain by the following notes. Thus—

1867. There were 320 male deaths, returned as from "Explosion, not stated how;" but most likely from fire-damp.

1869. Under chemical injuries, were included 30 deaths by "steam;" probably scalding by escaped steam, consequent upon explosion.

1871. There were 63 deaths this year, attributed to "gunpowder" explosion—all females—which were classed under "chemicals."

Table B. — Showing the Annual Deaths from Explosions, classed under Four Principal Heads —1852-79—(England and Wales).

Year.	Fire-damp.	Boilers.	Chemicals.	Undefined.	Totals.
1852	240	38	18	—	296
1853	194	16	31	—	241
1854	215	41	53	—	309
1855	128	41	46	—	215
1856	215	62	35	—	312
1857	No return. —	—	—	—	—
1858	—	—	—	—	—
1859	—	—	—	—	—
1860	—	—	—	—	—
1861	—	—	—	—	—
1862	—	—	—	—	—
1863	178	62	38	—	278
1864	119	50	57	—	226
1865	74	51	44	3	172
1866	191	65	41	—	297
1867	169	42	71	320	602
1868	246	23	123	—	392
1869	274	57	94	—	425
1870	196	59	68	—	323
1871	149	16	166	—	331
1872	173	10	92	—	275
1873	89	22	78	—	189
1874	194	24	86	—	304
1875	127	38	99	—	264
1876	191	21	141	—	353
1877	72	26	46	—	144
1878	313	21	70	—	404
1879	372	37	53	—	462
	4,199	822	1,550	323	6,814
Average of the 22 years	187·2	37·4	70·4	14·7	309·7

But apart from such momentary fluctuations, there is a clear lesson to be learned from Table B, and it is this—that while the deaths from boiler explosions show an almost continuous, although fluctuating decrease of late years, those resulting from explosions of chemicals show a most marked, although fluctuating increase. There can be but little doubt that this latter is the direction wherein danger to life and property chiefly lies.

Wider Range of Inquiry Necessary.

But, on the whole, it must be admitted that these tables, while they contain all the recorded deaths resulting from explosions in the chief divisions of the United Kingdom—England and Wales—do not convey an adequate idea of the consequences annually resulting from explosions.

For the other divisions of the kingdom, Scotland and Ireland, the returns of their respective Registrar-Generals do not furnish even returns of the deaths resulting from explosions; they are all comprehended in the general classification of "Violent deaths."

Non-Fatal Injuries.

The first point wherein the returns are deficient, and necessarily so, is in the matter of non-fatal injuries. Deaths alone come into the recorded

returns; but a very large proportion of the injuries resulting from explosions do not terminate fatally. If we take the experience of the Accident Insurance Companies—which is that 100 non-fatal injuries occur to each fatal injury—we have an aggregate annual average of 30,970 injuries to life and limb, resulting from explosions of various kinds, in England and Wales alone.

But even this last estimate does not measure the full consequences of the resulting evils, for in the cases of males killed, there are the widows and families usually left unprovided for to be brought into account. And here it becomes important to notice the ages, at the time of death, of the victims of explosions. Taking one year, 1879, as an example, the facts were as follows:—Of the total (462) deaths, there were at ages under 15, 52; at ages 15-20, 62; 20-25, 69; 25-35, 136; 35-45, 74; 45-55, 47; 55-65, 19; 65-75, 2; 75-85, 1. So that, in the great majority of instances, the persons killed had families dependent upon them.

Property Destroyed.

There at present exists no means of even estimating with exactitude the amount of property annually destroyed by explosions. It is sometimes very vast, as witness the consequences of the Gateshead explosion, 1854 (referred to, in detail, under "Chemical Stores," later in this paper); and of the Minneapolis Flour Mills, 1878 (spoken of in more detail, under title, "Flouring Mills," further on). But this point will be again referred to.

Localities of Explosions.

In view of completeness, it is desirable, at this point, to notice the localities of explosions, as indicated by the recorded deaths. For the purposes of the national death registration, England and Wales are divided into 11 geographical registration divisions, as follows:—

I. London.	VII. North Midland.
II. South-Eastern.	VIII. North-Western.
III. South Midland.	IX. Yorkshire.
IV. Eastern.	X. Northern Counties.
V. South-Western.	XI. Monmouthshire and Wales.
VI. West Midland.	

The deaths in 1879 were spread over these divisions as follows:—

i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	
4	10	3	4	5	31	5	27	35	7	331	— Total 462.

The location of collieries subject to explosion from fire-damp, determines the divisions wherein the greatest number of deaths from explosions will probably occur.

Detailed Records of Explosions, and their Causes.

Having now, I believe, exhausted all the available sources of statistical information, I still feel that the results presented are by no means adequate to the importance of the inquiry which I have undertaken; and it, therefore, becomes necessary to consider what further process of elucidation may be made available. This can, I think, be best accomplished by reviewing the chief "causes of explosions" in separate detail; and I accordingly proceed upon this new line of inquiry. I arrange the branches of inquiry in alphabetical order. I cannot pretend to make some of the sections exhaustive; they must be regarded as illustrative only.

Chemical Compounds and Processes.—Illustrative Cases.

1854.—October 6. Gateshead and Newcastle.—Fire broke out in a worsted manufactory adjoining a bonded warehouse. This latter was considered to be a double fire-proof structure, being supported on metal pillars and floors, and lined throughout with iron-sheeting. In this building was stored a large variety of chemical stores, and amongst these 47 tons of sulphur in one vault, covered with a tarpaulin to protect it; but on this tarpaulin was placed 45 tons of nitrate of soda. There was no gunpowder, charcoal, saltpetre, or naphtha stored there. The fire in the worsted warehouse caused the brickwork of the bonded warehouse to crumble away, and, ultimately, nothing remained on one side but the red-hot skeleton of the building. Some workmen, who had been engaged with nitrate of soda, predicted that it would explode, but this view was not generally entertained. Finally, one of the most terrible explosions of which we have any record in this country, occurred. By means of it the shipping on the River Tyne became ignited, and the fire was thus carried across the river into Newcastle, where many houses were burned, and others seriously damaged by the explosion. The property destroyed was estimated to have been of the value of £600,000, the loss mostly falling upon insurance offices.

An inquiry into the cause of the explosion was instituted, and in view of making its results clear, it is necessary to state that the chemical stores in the warehouse, beyond those already named, consisted of guano, alkali, fullers'-earth, ammoniacal charcoal, potash, yellow ochre, bone-ash, arsenic, zinc, iron, lead, magnesia, alum, and coal-tar. Mr. Hugh Lee Pattison, chemical manufacturer, being called as a witness, said he was of opinion that none of the substances named were explosive, *per se;* that no two would be explosive by being rudely mixed together; perhaps hardly any three of them would become explosive by being so mixed. He had made experiments for this occasion, and had melted nitrate of soda, and when perfectly fluid and red-hot had poured into it melted brimstone. There was produced certainly intense heat, but no explosion. Another element was therefore wanted, and that element was water. There was, he said, abundant evidence that when water comes in contact with intensely heated and melted saline matter, instant explosion takes place. It would be essential for the amount of water to produce its full effect, that it should fall upon the tested saline mass at once. A pint of water would cause a loud explosion. He of course thought it very unsafe to have such a quantity of combustible matter so placed as had been the case here; but he might have added that it was the efforts of the fire-brigade to extinguish the fire, by the application of water, that caused the explosion.

1867.—Fire occurred on premises where the business carried on was that of extracting oil from shoddy, the process being the following:—The shoddy is placed in an "extractor," into which is pumped from below bi-sulphide of carbon; this,

rising through the shoddy, disengages the oil, which flows off through a hole in the top of the extractor. The bi-sulphide is next drawn off, and steam introduced, which carries off the residue of of the bi-sulphide and oil remaining in the extractor into a still, where they are separated. The vapour which thus passes from the extractor is condensible at a temperature of about 109° Fahr. This vapour is highly inflammable, and, when mixed with air in the proportion of 1 to 15, is explosive. In the present case there was a leakage in the gaskin (or packing of canvas), which lies between the lid and rim of the extractor, coupled with a stoppage in the pipe between the extractor and the still. The vapour, escaping through the hole, ignited at the lamp, and set fire to some bags lying near; finally, the vapour becoming sufficiently mixed with the air, exploded, and caused considerable damage to the building, out of which arose the important insurance case, Stanley *v.* Western Insurance Co., 1868. This is a type of a large class of explosions in connection with chemical processes.

1878.—In Paris, on 15th May, this year, an explosion of chemical compounds occurred on the premises of a toy manufacturer, in the Rue Beranger, a leading thoroughfare of the city, whereby nearly 100 persons were killed or injured, and much property was destroyed.

1879. — Serious explosion in Newark, New Jersey, United States. The process being carried on was that of manufacturing celluloid. This substance is a species of solidified collodion, produced by dissolving gun-cotton (pyroxylin) in camphor, with the aid of heat and pressure. The gun-cotton is ground in water to a fine pulp, in a machine similar to that used in grinding paper pulp. The pulp is then subjected to powerful pressure in a perforated vessel, to extract the bulk of moisture, but still leaving it slightly moist for the next operation. This consists in thoroughly incorporating finely comminuted gum camphor with the moist gun-cotton pulp. The proportions employed are understood to be one part by weight of camphor to two parts by weight of pulp. After final pressure to expel the remaining moisture, the substance is cast in moulds to the form required, and constitutes an excellent substitute for ivory. It is now being used, combined with linen, for the manufacture of cuffs, collars, and shirt fronts, with many other articles of common use. It is liable to explode in several of its stages; and it may be regarded as presenting one of the newest dangers with which we are familiar. In the particular instance before us, how the materials ignited—whether by spontaneous combustion or otherwise—is not known. The substance is highly inflammable, as well as explosive, and demands the aid of science to provide an antidote for its dangers.

In the processes of distilling ardent spirits, carried on largely in thickly populated districts, there is always the risk of explosion, either (1) in the process retracting the crude spirit from the substance operated upon; or (2) in refining the spirit so obtained, especially the latter. But here the aid of science has been rendered largely available.

It seems desirable to give some further details regarding explosions of this class, hence I have prepared the following table:—

Table C.—Explosions of Chemical and Explosive Compounds otherwise than Gunpowder or Fireworks.

1837.	June 24.	...At Blaina Ironworks (Monmouth); 12 killed and much damage to property. Gases which had accumulated in a disused passage in the works. (See 1855.)
1842.	May 6.	...Hodge's Distillery. Explosion of vapour from spirits, a large quantity of which was destroyed.
1847.	July	...Hall's Gun-cotton Factory, Faversham; 21 killed and great destruction of property. Supposed to have originated through over-heating of premises.
1854.	Oct. 6.	......Chemical stores in bonded warehouse, Gateshead. Details already given.
1855.	Dec. 14.	...Explosion at iron furnace, Bilston (Staffordshire). about six tons of molten iron and burning cinders were blown about the works; 5 killed. (See 1837.)
1867.	Dec. 17.	...On Newcastle-moor; two cases of nitro-glycerine, taken there to be destroyed; 4 killed, including Mr. Bryson, town surveyor, who was superintending.
	Dec. 17.	...See the case of distilling oil from "shoddy," mentioned in the text.
1869.	June 30.	...Near Carnarvon; two cart-loads of nitro-glycerine; 5 killed, and damage done for miles round.
1870.	Sept. 11.	...Greenock; nitro-glycerine; 5 persons, who had taken shelter in the unoccupied shed where a small tin can of the compound was hanging on the wall, killed.
1871.	Aug. 11.	...Prentice's Gun-cotton Manufactory, Stowmarket (Suffolk); 20 killed, 70 injured. Enormous destruction of property. Supposed to be wilfully occasioned by the addition of acid at a certain stage of the process.
1872.	Aug. 1.	...Experiments with gun-cotton in the neighbourhood of the Treasury; windows broken and general alarm.
1875.	May 27.	...Chemical store, Washington-street, Boston, U.S.; 5 killed, 17 wounded; houses shattered.
1877.	Dec. 19.	...Great explosion of dynamite at entrance of St. Gothard Tunnel (Switzerland).
	Dec. 19.	...A dynamite factory at Gerona.
1878.	May 10.	...Part of freight on board Allan ship, *Sardinian*, while in Loch Foyle; 5 killed and 40 injured. The entire ship and cargo in jeopardy.
	May 17.	...Dynamite at Nobel's factory, Polmont (Stirlingshire); 2 killed.
	July 3.	...Dynamite at the Yarlside Mines, near Dalton-in-Furness.
1879.	May 16.	...At the Patent Cotton Gunpowder Company, Oare, Faversham; 1 killed.
	June	...Detonators at the Home-office Magazine, Woolwich.—It appeared that the detonators, some 12,000 in number, were confiscated by the police, under an order from the Lord Mayor, having been found improperly packed and unregistered on board a vessel from Hamburg. They were intended for blasting purposes, and were found on examination to be copper tubes, charged with fulminate of mercury. There was some idea of converting them to Government purposes, but the principal foreman of the cartridge works reported that this could not be done except at a loss, and he recommended that they should be destroyed by being placed, 1,000 a time, in diluted nitric acid. This recommendation was approved by Professor Abel, C.B., the War Department chemist, who had destroyed small quantities of detonators in a similar manner, and he now explains that the accident was due to the mistake of conducting the operation on too large a scale. The whole of the 12,000 detonators were plunged into the water at once, and before the fulminate could have become thoroughly wetted the nitric acid was poured in, creating a violent chemical excitement such as to detonate a particle of the mercury and produce the explosion.
	Nov. 7.	...At Templecombe (Dorset); benzoline vapour exploded from contact with lighted candle.
1880.	March 5.	...At Craig (near Montrose) Railway Works; 5 killed and 1 injured.
	April	...Tar-distilling works at Silvertown; 11 killed and several injured. [First accident of this kind.]
	April 26.	...Benzine at a druggist's in Alessandra (Italy); 8 killed and 8 injured.
	April 28	...Cork; the extensive premises of Messrs. Goulding, chemists and oil merchants; several explosions.

1880. May 5. ...Dynamite in a railway waggon, at Stratford, Ontario; 2 killed and others wounded.

May 5. ...At Messrs. Hodgkinson's, wholesale druggists, Aldersgate-street. Vapour from aniseed, heated by gas; several killed; great destruction of property.

May 8. ...Dynamite magazine of St. Gothard Railway (Faido); 18 killed and wounded. From 40,000 to 60,000 cartridges exploded.

May 30. ...The ship, *Sapphire* of Antwerp), in Philadelphia Docks; cargo exploded.

July 16 ...At the Runnymede Engineering Works, Egham, Surrey.—A group of buildings used by Mr. Postlethwaite for the construction of torpedo and other steam-launches. The establishment is in close proximity to the Thames, and is surrounded by waste land, upon a portion of which a Norwegian gentleman has been engaged in the composition of a new fulminate for the detonating caps of the torpedoes used in naval warfare. A cask of this new composition, which, when first mixed, looks very much like ale with yeast on the surface, had been left in a small temporary wooden building, situated about 50 yards from the works, in order that the material might get dried by evaporation; and the substance, heated by the sun, or fired by a flash of lightning, suddenly exploded, with a sound like a clap of thunder. The temporary shed and its contents were blown to atoms, and a piece of the *débris* slightly wounded a boy who was fishing 60 yards off on the river bank. Very fortunately, the men had left work.

Aug. 7. ...In the laboratory, Government Arsenal, Bridesburg, Philadelphia; 2 killed, 10 wounded.

Aug. 13....Benzine in ship, *Hansa*, in Lubeck Harbour; 12 persons injured, and ship much burned.

Nov. 13....At Her Majesty's Theatre; explosion from accident to lime-light.

Note.—Experiments were made in December, 1880, by the officers of the Royal Arsenal, Woolwich, in company with Mr. Baker, her Majesty's Inspector of Mines, and Major Majendie, Royal Artillery, the Inspector of Explosives, with the view of ascertaining, if possible, the cause of the accidental firing of blasting charges in mines and quarries. Serious consequences have frequently resulted from the deterioration of these charges while being forcibly driven into the borings, and many men have been blinded from this cause. Great uncertainty exists as to the conditions which create or contribute to the premature ignition, and, therefore, a day was devoted to experiments, in the hope of elucidating some information on the subject, and perhaps avoiding the recurrence of such accidents in future. Charges of gunpowder were accordingly subjected to violent treatment of various kinds, such as they might meet with under most unfavourable circumstances in actual practice; but in no case did blows or pressure bring about an explosion, however excessive the application.

This is a miscellaneous table, designed to show the varied circumstances under which explosives and explosive compounds work destruction to life and property; and new compounds are constantly being discovered. I am glad to see that experiments are being made from time to time, in view of lessening the explosive force during the transport of substances required in considerable quantities. Regarding explosions on board ship—a source of the greatest danger—it is clear that more severe regulations than any heretofore in force are required.

Explosions in Collieries.

One of the most frequent, as well as one of the most destructive forms of explosion, is that from fire-damp in collieries. In certain districts of the kingdom, such events are of common occurrence, and the sacrifice of life is immense. Science, in the discovery of the safety lamp, and by various other means, has already lent remedial aid. I venture to think that it may yet accomplish much more, and in a direction which I shall hereafter indicate. I propose now to give a table of the more important of such explosions during the present reign, drawing largely in the middle portions upon the data contained in Mr. Neison's "Preliminary Report" on the rate of fatal and non-fatal accidents in and about mines and railways, 1880.

Table D.—Explosions in Coal Mines Resulting in the Death of Five Persons and Upwards, 1838-80 (United Kingdom).

Note.—These resulted from Fire-damp, unless otherwise stated.

Date.	Colliery and Location.	No. of Lives Lost.	Observations.
1838. Oct. 24..	"John Pitt" (Whitehaven) ...	35	
1839. Feb. 18..	"William" (Cumberland)......	23	
June 28.	St. Hilda's (S. Shields)............	60	
1841. Aug. 6...	Thornley (Sunderland)	9	
1843. April 7..	Stormont (Newcastle)	27	
1844. Sept. 28.	Haswell (Durham)	95	
1845. Aug. 2...	Cwmbach (Merthyr)	28	
Aug. 21.	Jarrow (S. Shields)	39	6 explosions in 28 years.
1846. Jan. 14..	Risca (S. Wales)......................	35	(See 1853.)
1847. March 5	Oaks (Barnsley)......................	70	(Sec 1865.)
June 29.	Kirklep Hall (Wigan)............	13	
1848. Aug. 17.	Newton (Seaham)..................	14	
Oct. 28..	Whinnyhill (Whitehaven).......	30	
1849. Jan. 24..	Darnley Main (Barnsley)	75	
March 6	Middle Patricroft (Wigan)......	12	
June 5...	Hebburn (Newcastle)	33	
Aug. 11.	Lletty Skenken (Aberdare) ...	52	
1850. Nov. 16.	"Rock Pit" (Haydock)	11	
July 23..	Commonbend (Airdrie)	20	
Nov. 11.	Houghton (Durham)	26	
1851. Mar. 15.	Nitshill (Paisley)	61	
Mar. 25.	Arley (Wigan)	58	
Aug. 18.	Washington (Newcastle)	35	
Dec. 20..	Rawmark (Rotherham)	52	
1852. May 20..	Downbrow (Preston)	35	
1853. Mar. 12.	Risca (S. Wales)	10	(See 1846 & 1880.)
July 1 ...	Bent Grange (Oldham	17	
1854. July 18..	Arley (Wigan)	189	
1856. July 15..	Cymmer (Pontypridd)	14	
Aug. 12.	Ramrod (Oldbury)	111	
1857. Feb. 19..	Land Hill (Barnsley)	89	
Aug. 2..	Hays (Ashton)	40	
1858. Feb. 2...	Bordsley, (Ashton-under-Lyne	50	
Feb. 24..	Lower Duffryn (S. Wales)......	20	(See 1860.)
Oct. 1....	Pagebank (Durham)...............	10	
Oct. 13..	Primrose (Swansea)	13	
1859. Mar. 20.	South Killoe (Durham)	5	
1860. Feb. 15..	Higham (Yorks)	13	
Mar. 3...	Burradon (Northumberland)...	76	
Aug. 3...	Winstanley (W. Lancashire)...	13	
Nov. 6...	Lower Duffryn (S. Wales) ...	12	(See 1858.)
Dec. 1 ...	Black Vein (Monmouth).........	142	
Dec. 20..	Mirror Pit (S. Durham)	22	
1861. Feb. 6 ...	Brereton (S. Durham)	7	
Feb. 27..	Linnyshaw (N. Lancashire) ...	9	
Mar. 8...	Blaengwawr (S. Wales)	13	
Sept. 26.	South Mostyn (W. Lancashire)	10	
Nov. 1...	Sherrington (W. Lancashire)...	13	
1862. Feb. 19..	Cittim (S. Wales)	47	(See 1865.)
April 4..	Westwood (Yorks)	6	
Nov. 22..	Walker (Northumberland)......	16	
Dec. 8 ...	Edmund's Main (Barnsley)......	59	
1863. Mar. 6...	Coxlodge (Northumberland) ...	26	
June 26.	Park (S. Wales)......................	6	
Oct. 17..	Morfa (S. Wales)	39	(See 1870.)
Dec. 9 ...	Wynstay (W. Lancashire)	13	(See 1868.)
1864. Mar. 2...	Brookhouse (N. Staffordshire).	5	
Sept. 9 ..	Seghill (Northumberland)	7	
1865. Mar. 1...	Clough Hall (N. Staffordshire)	5	
May 3 ...	Clay Cross (Derbyshire	8	
June 16.	Tredegar (Monmouthshire)	26	
Dec. 20..	Cittim (S. Wales)	34	(See 1862.)
1866. July 23..	Park-lane (W. Lancashire)......	30	
May 4...	Garswood-pk. (W. Lancashire)	12	
June 14.	Dunkinfield (N. Staffordshire).	38	
Oct. 31..	Pelton (S. Durham)	24	
Dec. 10..	Bank (N. Lancashire)	8	
Dec. 12..	Oaks (Barnsley)......................	334	(See 1847.)
Dec. 13..	Oaks (Barnsley).....	27	
Dec. 13..	Talk-o'-th'-Hill (N. Staffordshire)	91	
1867. May 30..	Mesne Lea (N. Lincolnshire)...	7	
Aug. 20.	Garswood-pk. (W. Lancashire)	14	
Nov. 8...	Ferndale (S. Wales)	178	(See 1869.)
Nov. 12.	Hornerhill (S. Staffordshire) ...	12	

Date.		Colliery and Location.	No. of Lives Lost	Observations.
1868.	Sept. 30.	Wynstay (W. Lancashire)	10	(See 1863 & 1873.)
	Oct. 2 ...	Green Pit, Ruabon	10	Many injured.
	Nov. 25.	Hindley-green (W. Lancashire)	62	
	Dec. 21..	Morley (W. Lancashire)	8	
	Dec. 26..	Haydock (W. Lancashire)	26	(See 1869.)
1869.	July 29..	Springwell (Northumberland).	5	
	April 1..	High Brooks (W. Lancashire).	37	
	May 25..	Cwmnantddu (Monmouth)......	7	
	June 10.	Ferndale (S. Wales)	53	(See 1867.)
	July 21..	Haydock (W. Lancashire)	59	(See 1868 & 1878.)
	Aug. 2...	Burg (near Dresden)	269	
	Oct. 22..	Newbury (Monmouth)............	11	
	Nov. 11..	Hendreforgan (S. Wales)	6	
	Nov. 15..	Low Hall (W. Lancashire)......	27	
1870.	Feb. 4 ...	Pendleton (N. Lancashire)......	9	
	Feb. 14..	Morfa (S. Wales)	30	(See 1863.)
	Mar. 4...	Dunkirk (N. Staffordshire) ...	9	
	July 7 ...	Silverdale (N. Staffordshire)...	19	(See 1872.)
	July 23..	Charles (S. Wales)	19	
	Aug. 19.	Bryn Hall (W. Lancashire) ...	20	
	Sept. 27.	Pendlebury (N. Lancashire) ...	6	
	Oct. 8 ...	Abercromby (S. Wales)	5	
1871.	Jan. 10..	Renishaw-park (Derbyshire)...	26	
	Jan. 12..	Leycett (N. Staffordshire)	8	
	Feb. 24..	Pentre (S. Wales)	38	
	Mar. 2...	Victoria (Monmouthshire)	19	
	Sept. 6 ..	Ince Moss (W. Lancashire) ...	70	
	Sept. 20.	Ince Moss (W. Lancashire) ..	5	
	Oct. 25...	Seaham (S. Durham)	26	
	Nov. 15..	Hindley Green (W. Lancashire)	6	
	Nov. 22..	Norwood (Derbyshire)............	9	
1872.	Feb. 14..	Maesteg (S. Wales)	11	
	Mar. 12.	Berry Hill (N. Staffordshire)...	6	
	Mar. 28.	Lover's Lane (N. Lancashire).	27	
	Oct. 7 ...	Morley (Yorks)	34	
	Dec. 21..	Silverdale (N. Staffordshire)...	8	(See 1870.)
1873.	Feb 18..	Falke (N. Staffordshire)	18	
	April 5..	Tillery (Monmouth)...............	6	
	April 24.	Wynstay (W. Lancashire)	7	(See 1863 & 1868.)
	May 31..	Bryn Hall (W. Lancashire).....	6	(See 1870.)
	Nov. 21.	Mesnes (W. Lancashire).........	7	
	Dec 2...	Hafod (W. Lancashire)	5	
1874.	April 14.	Astley Pit (N. Staffordshire)...	54	
	July 18..	Ince Hall (W. Lancashire)......	15	
	Nov. 20.	Rowmarsh (Yorkshhire)	23	
	Dec. 7 ...	Ogmore (S. Wales)	5	
	Dec. 24..	Bignall-hall (N. Staffordshire).	17	
1875.	Jan. 5 ...	Aldwarke (Yorks)	7	
	April 30.	Bunker's Hill (N. Staffordshire)	43	
	Dec. 4 ...	New Tredegar (Monmouth.)...	23	
	Dec. 6 ...	Swaithe Maine (Yorks)	143	
	Dec. 6 ...	Llan (S. Wales)....................	16	
	Dec. 9 ...	Methley (Yorks)	6	
1876.	Jan. 5...	Jammage (N. Staffordshire) ...	5	
	April 6..	Silverdale (N. Staffordshire)...	5	
	June 26.	Birley (Derbyshire)	6	
	Dec. 18 .	S. Wales (Monmouth)............	23	
1877.	Jan. 23..	Stonehill (N. Lancashire)	18	
	Feb. 7 ...	Foggs (N. Lancashire)...........	10	
	Mar. 6...	Great Boys (N. Lancashire) ...	8	
	Mar. 10.	Weigfoch (S. Wales)	18	
	Oct. 11 ..	Pemberton (W. Lancashire) ...	36	
	Oct. 22..	Blantyre (E. Scotland)............	207	
1878.	Feb. 17..	Whiston (W. Lancashire)	7	
	Mar. 8...	Barrwood (W. Scotland).........	17	
	Mar. 12.	Unity Brook (N. Lancashire)...	43	
	Mar. 27.	Apeldale (N. Staffordshire) ...	23	
	May 30..	Pendwll (W. Lancashire)	6	
	June 7...	Haydock (W. Lancashire)	189	(See 1868-9.)
	Sept. 11.	Abercarn (Monmouthshire) ...	268	
1879.	Jan.13...	Dinas (S. Wales)	64	
	Jan.24	Fitzwilliam Hemsworth (Barnsley)	5	1st explosion.
	Mar. 4	"Deep Drop," or Silkstone Pit (Wakefield)	19	
	Ap. 16	Agrappe, Mons. (Belgium)......	240	(See 1880.)
		Short-heath (Staffordshire) ...	6	
	Dec. 24..	Kersley (near Bolton)	7	
1880.	Jan. 21..	Leycett (N. Staffordshire)	?	
	July 14..	Risca, Newport (S. Wales)......	119	(See 1846 & 1853.)
	Aug. 3 ..	Benham, Wrexham (N. Wales)	8	
	Sept. 8 ..	Seaham (Durham)..................	165	
	Nov.19	Grand Buisson, Mons. (Belgium)	27	(See 1879.)
	Dec. 10	Pen-y-Graig, Rhondda (S. Wales............................	101	

The result of the 156 colliery explosions enumerated in this table, summarised into months, stands as follows :—

	No. of casualties.	No. of deaths resulting.		No. of casualties.	No. of deaths resulting.
Jan.	13	 278	July	8	 382
Feb.	18	 580	Aug.	13	 552
Mar.	20	 531	Sept.	10	 642
April....	9	 425	Oct.	13	 480
May	7	 81	Nov.	14	 424
June	9	 424	Dec.	23	.. 1,170

The lightest month is, therefore, May, taking the number of casualties and the resulting mortality together; July has one more casualty, but a much heavier mortality; April and June rank next; then September; January, August, and October have a like number of casualties, but in the latter months the fatality has been much more serious; November is heavy; but the three really heavy months are February, March, and December—the latter more especially so. Now an examination of the state of the barometer and thermometer during a series of years should surely throw some light upon the causes then in operation, and, perchance, indicate the means of future avoidance. See also section "Dust."

The most fatal year embraced in Table D appears to have been 1866—accounted for by the great catastrophe at the "Oaks" Colliery, Barnsley, where poor Jeffcock voluntarily sacrificed his life in a vain endeavour to afford relief. But 1880 is also a very heavy year. The years 1868 and 1873 were each remarkably fatal in West Lancashire; whilst 1877 stands out in the annals of coal-mining in Scotland with fatal prominence. It is, indeed, noticeable how certain entire districts appear to become disturbed at certain periods, and then remain quiescent for years. Will volcanic influences in any degree account for this? I have added a few casualties.

The inspection of collieries was provided for in 1850, by 13 and 14 Vict. c. 100. New provisions were introduced in 1855, by 18 and 19 Vict. c. 108, and again in 1860 by 23 and 24 Vict. c. 151. In 1872, by 35 and 36 Vict. c. 76, the regulations of the preceding measures were consolidated and amended, and boys were prohibited from working in collieries. In 1862, an Act was passed rendering it incumbent upon colliery proprietors to provide duplicate shafts.

Attention was, in 1879, directed in the French Academy to a case of explosion of carbonic acid which occurred in July of that year in one of the coal pits of Rochebelle (Gard). The coal strata there are much dislocated, and the carbonic acid, generated plentifully in the neighbourhood, and finding its way through natural passages, seems to have accumulated in certain parts with sufficient tension to explode with two loud detonations, driving a large quantity of fine coal into the galleries. Three men were asphyxiated, and two others were only able to throw themselves in a swooning state into the cage and be hauled up. That no flame was present (as in explosions of fire-damp) is proved by the absence of burns on the bodies of the victims, the fact that blasting cartridges did not go off, and other circumstances. The gas is thought to have arisen from sulphuric acid (produced through oxidation of a stratified mass of pyrites) dissolving in subterranean

waters, and finding its way down to triassic limestone. In the works of M. Kuhlmann, lately, an alembic of platina, about 90 centimètres diameter, used for producing daily some 6,000 to 7,000 kilog. of concentrated sulphuric acid, was exploded, the component pieces being shattered and thrown out, with bricks of the fire-place, 20 to 30 mètres in different directions. Fortunately a slight hissing was observed a few seconds previously, so that the workmen had time to escape a terrible fate. The nature of the explosion M. Kuhlmann supposes to be as follows:—This platinum apparatus was being cleaned; some 30 to 40 kilogrammes of concentrated sulphuric acid had been left in it; on this some water had been admitted through the siphon, and the whole had been gently heated three or four hours. It is known that mixing sulphuric acid with water produces a good deal of heat; in the present instance, combination is thought to have taken place instantaneously at a high temperature, generating a large amount of vapour. From data furnished by Fabre and Silbermann, it appears that 40 kilogrammes of acid at 18°, with water, is capable of producing, instantaneously, 18 to 20 cubic mètres of vapour, and this is sufficient to explode a platinum vessel of about 300 litres capacity, and only 2 to 3 mm. thickness. As the combination occurred at about 100°, the force would be greater. M. Kuhlmann has repeated the explosion several times in laboratory experiments, and he finds that it always occurs with great violence where the quantity of water is at least ten equivalents for one of acid. In presence of the difficulty of mixing these two substances, which have a very great affinity, but the density of which is so different that they may remain several hours one on the other without mixture and consequent combination, the need of cautious management is obvious.

Proposals are now being brought forward for lighting collieries with the electric light; this does not appear to me, in the nature of the case, to be possible, seeing the position in which the men have to work, in their seams especially; but where it can be done, safety should result.

There is now sitting a Royal Commission on explosions in coal mines, whose report will be looked forward to with much interest.

DUST.

It was long known that dust was highly inflammable before it was at all suspected that it was explosive. An instance of its intense inflammability was particularly recorded in the case of a woollen mill at Millville, Massachusetts. The workmen were lighting the gas in the carding-room, the dust and fibre hanging to the gas-pipe ignited, and in an instant the flames had spread entirely over the room, and the building was speedily destroyed. Later instances have been more carefully observed. But, in truth, the investigation into the destruction of the Tradeston Mills, Glasgow, had already determined that flour, when combined with the atmosphere in certain proportions, is explosive. Why not, then, other finely pulverised substances?

TABLE E.—EXPLOSIONS ARISING FROM DUST OF VARIOUS DESCRIPTIONS.

1877. Dec. 13.....Brewery (Messrs. Alsopp's), Burton-on-Trent.—A workman provided with an unprotected light, shortly after the starting of some new works, on attempting to make an examination of the working of a leather band, was met, on the opening of the door leading into the casing, with an explosion sufficiently powerful to throw the band out of gear.

Another brewer has since stated that no less than three explosions had occurred on his premises. Hence the pulverised malt combs must be held to be explosive when mixed with the air, by the rapid movement of the machinery, or otherwise.

1877. Dec. 20.....At a wholesale candy establishment (Mr. Greenfield's) in New York; two lives lost, and much property destroyed. The opinion of experts, after it was found that the boiler had not exploded, was that gas had accumulated in the flue connecting the boilers with the chimney; but subsequent events leave no doubt that it was occasioned by dust, evolved in the manufacturing the candy on the premises. The loss to the insurance offices was very large. (See August, 1879).

1879. ...An explosion occurred, which gave rise to the theory that coal-dust will explode under certain conditions. Mr. Morrison, of Newcastle, tried experiments with anthracite coal-dust. He found this would, under certain conditions, ignite in a safety lamp.

August ....Another explosion in a French candy factory in New York.—A workman, while bearing a tray containing moulds of pulverised corn-starch in the drying-room, stumbled and fell; the falling threw a heavy cloud of finely-divided starch-dust against a red-hot furnace; an instant explosion resulted. It was found the moulds had become so dry, and so highly inflammable from constant use, that only a rude shake was needed to fill the air with explosive particles.

Nov. 7......In Kansas City, at a cracker (biscuit) and candy factory; 7 killed, and much property destroyed; fire following explosion.

The facts here noticed gave rise to a new theory, viz., that explosions in coal mines might sometimes arise from coal-dust, instead of fire-damp; Mr. W. Galloway therefore commenced a series of experiments, and communicated the results to the Royal Society. He stated that a certain mixture of air and coal-dust, not inflammable at ordinary pressure and temperature, becomes so when 0·892 per cent. of fire-damp (by volume) or more is added. It then burns freely with a red, smoky flame. In a dry and dusty mine an explosion may, he said, extend itself to remote parts of the workings where fire-damp is quite unsuspected. The wetness or dryness of the workings he stated to depend on the temperature of the strata in which they are situated, for if the temperature of the mine is lower than the dew point of the air at the surface, the ventilating current will deposit moisture as it becomes cooled in passing through the workings; and if, on the other hand, the temperature of the mine is higher than the dew point at the surface, the ventilating current will absorb moisture and tend to produce a state of dryness. He then pointed out that the temperature of the strata in the coal measures of this country increases at the rate of about 1° Fahr. for every 60 ft. below the surface, and therefore the comparative wetness or dryness of a mine depends on its depth. He has found that his own observations gave these results—that mines shallower than 400 ft. are damp, and those deeper than 700 ft. are dry and dusty. Between the 400 ft. and 700 ft. there is a kind of debatable ground, in which wetness or dryness depends for the time being on the temperature of the air entering the mine at the surface. In all dry coal mines the coal-dust lying on the floor of the roadway rises in clouds and fills the air when it is disturbed by the passage of men,

horses, and wagons, and a sudden puff of air such as that produced by a local explosion of fire-damp, or by a shot blowing its tamping, must necessarily produce the same effect in a greater or less degree, according to its intensity. Although 0·892 per cent. of fire-damp will cause an explosion, it is probable that under compression in a confined space a less amount may have the same effect.

Mr. Galloway propounded the theory that some kinds of coal-dust may, perhaps, require less fire-damp than others to render their mixture with air inflammable, and suggested that still other kinds may form inflammable mixtures with pure air. On the other hand, he mentioned an experiment with the return air of a mine where he found that the air had to be black with dust before ignition occurred. He mentioned that it was a favourite theory that fire-damp suddenly bursting from strata would cause an explosion of wide extent, and that traces of it could afterwards be found in the charring of the timber used in the mine. This so-called appearance of charring was, he said, due to a coating of the coked coal-dust adhering superficially. The practical suggestion made was that roadways in mines should be kept well watered to lay the coal-dust. In the case of the Dinas explosion (of the 13th of January), he had found on his last visit before the explosion that the water-carts were not being used. The manner, he said, in which coal-dust operates in setting fire to coal and timber is probably as follows:—The air is travelling rapidly in one direction along a gallery, throwing a continuous shower of dust, small pieces of coal, &c., against all surfaces in its course; at the instant the flame traverses it the coal-dust is melted; it then assumes the properties of flaming pitch, adheres to the surfaces against which it is thrown, and rapidly accumulates until it forms a crust of a greater or less thickness, according to the length of time the air continues to travel in the same direction. If there is enough air it will continue to burn, but if not it is soon extinguished, and a covering of "coke" results, and there is the appearance vulgarly call "charring." This throws a new light upon the circumstances attending colliery explosions in certain cases, and one which we may be sure scientific men will follow up.

Fireworks, Gun Caps, Cartridges, Rockets, and War Munitions.

Fireworks, employed for amusement, as also the more serious munitions employed in warfare, and the manufacture of sporting cartridges, &c., have been, and still are, attended with great danger; although legislation has done something to insure greater safety. I propose here to record some of the more serious casualties resulting from these causes:—

Table F.—Explosions arising in the Manufacture of Fireworks and Munitions for Sporting and Warfare.

1715.	Jan. 13	Firework maker, Thames-street, London. Fireworks were being made on a large scale, in preparation for the king's coming to St. Paul's. 37 barrels of powder on the premises. The house blew up, and the ruins spread into a large conflagration, consuming more than 100 buildings. It is recorded, as an historical incident, that a child in its cradle was blown on to a neighbouring church, and its life saved.
1766.	July	America.—At Hartford (in Connecticut), a party of 22 young gentlemen were engaged in the school-house preparing fireworks for the rejoicings that were intended on the news being received of the repeal of the Stamp Act (by the British Government). The barrels of gunpowder in use for the purpose were stored in the lower room of the building. A negro boy, seeing some grains scattered on the floor, raked them together, and fired them. This exploded the entire mass, blowing the building into fragments, and killing all but two or three. Another explosion was reported from Sea-brook on the same occasion, of which we have no details.
1842.	March 1	D'Ernst's firework factory, Lambeth; 4 killed—all employed.
	May 4	At Apothecaries' Hall, London, explosion of bomb-shell during experiments; operator killed, and buildings much injured.
1845.	Sept. 17	Royal Arsenal, Woolwich; the explosive substance from old fusees exploded; 7 killed, much property damaged.
1849.	Oct. 12	Barling's firework factory, Bermondsey; 4 killed.
1850.	Sept. 16	Firework factory in Weaver-street, Spitalfields, destroying the premises, and 38 adjoining houses; injuring a great number of persons.
1851.	Dec. 2	Rocket factory, Deptford; 7 killed.
1854.	March 6	Firework manufactory, Westminster-road; 2 killed.
1855.	Oct. 7	Firework manufactory, Green-street, Liverpool; lightning.
1857.	Feb. 26	Fog-signal factory of Great Eastern Railway, at Stratford; 3 killed, and extensive premises destroyed.
1858.		Bennett's firework manufactory, Westminster-road; 5 killed, 300 more or less injured.
1859.	Sep. 27	Phillips and Pursall's percussion cap manufactory, Birmingham, in which was stored, in process of finishing, 5½ millions of caps; from 3,000 to 4,000 cartridges, and a large quantity of explosive materials; 21 killed, and large building destroyed.
1861.	Jan. 21	At Chatham Arsenal, caused by bursting of hand-grenade in process of manufacture. Various minor explosions followed the chief one; great destruction.
1862.	July 21	Walker's percussion factory, Birmingham; 9 killed, 14 seriously injured, and premises destroyed.
1865.	Sept. 21	Firework manufactory at Manchester.
	Sept. 26	Firework manufactory at Bristol.
1867.	Oct. 9	Hammond's firework manufactory, Canongate, Edinburgh; 5 killed, 11 injured.
1868.	May 29	Fog-signal manufactory at Saltley; lightning.
	Sept. 18	Cartridge manufactory at Metz; 36 killed and 110 injured.
1869.	Oct. 1	Fireworks in shop, Moscow-road, Bayswater; 4 killed.
1870.	Dec. 9	Ludlow's Cartridge Factory, Witton, Birmingham; over 40 of the workpeople (mostly girls) killed.
1871.	May 17	Cartridge factory in the Avenue Rapp, Paris; more than 50 killed.
	Dec. 31	Cartridge factory, Fort of Agra; 25 killed.
1872.	Jan. 18	Gladstone cartridge factory, Greenwich; 30 girls injured.
	Mar. 40	Fuzee factory, Cambourne, West Cornwall; 8 girls killed.
1873.	Nov. 4	Firework maker, Brook-street, Lambeth; 8 killed—all in the house.
1878.	Feb. 12	Detonator Factory of Cotton Powder Company, Dare, Faversham; 2 injured.
1878.	Dec. 23	Afghan Rockets at Royal Laboratory, Woolwich; 4 men seriously injured. These rockets were of extraordinary size, being nearly 4 ft. in length by 6 in. diameter, weighing 95 lbs.
1879.	April 19	Royal Arsenal, Woolwich; explosion of a special character, 1 killed.
1880.	May 1	Ancon, Peru. A large torpedo, of new proportions and of extraordinary power, which was in course of completion at the manufactory of those instruments, exploded with a report like the roar of a battery of heavy guns, and a concussion of tremendous violence, shaking every house in the town, breaking all the glass in the windows, and spreading alarm through the population generally. The manufactory was blown to pieces, and every inmate destroyed. Six houses adjoining were levelled to the ground, not a stone remaining upon another.
1880.	Sept.	At a Cartridge Factory, Bridgeport, Connecticut 5 killed.

As early as 1667—a year after the great fire—the

City of London passed an ordinance containing the following :—

"xxvi. *Item*.—That no person whatever be henceforth permitted, at any time, to make or cause to be made any sort of firework, or to fire or cause to be fired any such fireworks, within the City or Liberties thereof, except such persons only as shall be thereunto appointed by H. M., or any lawful authority under him."

Another ordinance on the same subject was promulgated in 1697.

In 1875—by 38 and 39 Vict., cap. 17—regulations were enacted regarding firework manufactories (Sec. 48), and under this Act prohibitive measures have been taken. The manufacture can no longer be carried on in densely populated districts.

Flouring Mills.

Some ten years ago, it would have seemed quite out of place to introduce such a title amongst the causes of explosion; not that such may not have then happened, but because science had not then recognised their possibility. It was, indeed, known that dust was inflammable, and highly so, but as already stated, not that it was explosive. It was the scientific investigation which followed the burning of the Tradeston Mills, near Glasgow, in 1872, that first determined the explosive properties of grain-flour under certain conditions. I have no means of ascertaining the number of flour mills in the United Kingdom, but they can probably be reckoned by thousands. In Hungary, in 1872, there were 20,691 water, and 482 steam flour-mills —total 21,176 ; in the United States, in 1879, there were about 24,000 flouring mills. Anything affecting the safety of these may therefore be regarded with interest.

I now proceed to furnish a brief list of the flour-mills which, in the light of 1872, may be regarded as having been destroyed by "explosion":—

Table G.—Explosions in Flouring-mills.

1864. Sept. ......The "Stow Mills" at Masconta, Illinois. They were grinding "middlings." *i.e.*, flour of the middle quality, as distinguished from the finer or coarser samples. About three o'clock in the morning, the miller in charge went up to the chamber (a large box extending through several storeys), as he had often done before, "to jar the middlings down"—they having clogged. He carried a small oil-lamp, which he placed on a beam just behind and above his head. He then opened a slide, and thrust in a shovel, which started the flour down with a thump, raising a cloud of dust, when instantly, as if it had been coal-gas, it flashed, burning the miller's hair and beard, and filled the box with a sheet of flame, which spread with great rapidity, and burned the mill.

This incident drew attention to the circumstances attending the burning of a flour-mill at Dover, Kentucky, several years before. Here the floor of the flour-box gave way with the weight of a man, great dust was created, which, the instant it reached the furnace in the boiler-room, to which it was naturally drawn down, ignited with an explosive flash, and burned the mill.

1868. Nov. 20 .. Schmidt & Co.'s Mill, St. Louis. The light, or globe-lamp, was held near a bran spout, extending the height of the mill. The dust ignited with a flash, and burned the mill.

1869 Sept. ......Bertchey's Mill, Milwaukee. The fire originated in a candle being held near a feed-spout reaching through the mill. The ignition was instantaneous—several parts of the mill appearing to be on fire at the same moment.

1872. July 9......Tradeston Mills and Granaries, near Glasgow. Explosion, followed by fire. The circumstances seemed inexplicable, and the fire offices interested instructed Mr. W. J. Macquorn Rankine, C.E., LL.D., F.R.S., and Mr. Stevenson Macadam, Ph.D., F.R.S.E., to investigate and report. The following embodies the substantial result of this inquiry :—

" . . . We have made a searching investigation into all the circumstances connected with this disastrous affair, and having inspected the premises, examined all surviving witnesses, visited various other mills, and inquired, by the examination of witnesses and documents, into the list of other fires and explosions of a like nature, we have to report as follows :—

"1. That the primary cause of the fire and explosion was the accidental stoppage of the feed of one pair of stones engaged in the grinding of sharps, which led to the stones becoming highly heated and striking fire. 2. That the fire thus generated inflamed the finely divided dust which was diffused through the air in the exhaust-conduits, and then passed on to the exhaust-box. 3. That the sudden combustion of the dust diffused through the air would produce a very high temperature in the gaseous products of that combustion, and this would necessarily be accompanied by a great and sudden increase of pressure and bulk—constituting, in fact, an explosion. 4. That the first effects of this explosion would be to burst the exhaust-box, and allow of the diffusion of the dust and flame through the atmosphere of the whole mill. 5. That this communication of inflammable dust and flame throughout the atmosphere of the whole mill was the cause of the second explosion, by which the gable walls were blown out, the mill reduced to ruins, and the wood-work set on fire. 6. That the stores or granaries were set fire to partly by the flame and fire from the mill travelling along the gangways, and partly from the burning materials falling through the sky-lights. 7. That no explosive or other foreign material was used in the manufacture of the flour, and that we found the steam-boilers uninjured. 8. That we have not been able to trace blame on the part of the proprietors of the mill, or of any one in their employment, as every precaution known at the time was used."

Passing from the particular to the general, they say :—

"We have ascertained, both from the evidence of eye-witnesses, and from printed and published documents, that fire-explosions, similar in their cause and nature to that at Tradeston Mills, are accidents of ordinary occurrence in flour-mills, especially since the introduction of the apparatus called the 'exhaust.' This fact, however, is little known to the general public, or indeed to any one except those practically employed in working such mills, though it appears to be better known on the Continent than in Great Britain, being mentioned in French and German treatises on flour-mills, but not to our knowledge in the standard English books on that subject. . . . . It requires some consideration to see the reason why such fire-explosions are not much more frequent than they have been."

1878. May 2......Washburn Mills, Minneapolis, probably the largest flouring mills in the world (containing 41 run of stones), and 5 neighbouring mills—6 in all. The building wherein the explosion occurred contained two independent mills under one roof, and was $7\frac{1}{2}$ stories high, grinding from $1\frac{3}{4}$ to 2 million bushels of wheat per year. The night hands had just come when, at 7.20 p.m., the explosion occurred; the whole building was levelled with the ground, and the entire city suffered a shock as from an earthquake, nearly all the windows being broken, and large stones thrown into the air descended through their roofs. The conflagration of the ruins extended the fire to much other property, so that the entire loss was estimated at near upon £200,000.

Many theories were again started, as that the Minnesota wheat contained more sulphur than that from any other State ; but the facts brought to light in the "Tradeston" investigation afforded an entire solution.

Note.—Mr. John B. Kehl, proprietor of the Glen Flouring Mills, Chipewa Falls, Winsconsin, has since forwarded an account of a small explosion which he personally witnessed in his own mill.

Science has here stepped in and afforded the required relief. By means of powerful magnets fixed in the hoppers, particles of iron which formerly got mixed with the grain from the wire binding of the sheaves are now intercepted; particles of dirt are otherwise disposed of; and by means of gauze wire screens the dust is kept from contact with the artificial lights employed.

Gas (Coal.)

The use of coal-gas for illuminating and domestic purposes took its rise early in the present century. It is impossible to estimate the precise degree of danger to life and property which have resulted. Hundreds of gas explosions occur every year; but many of these are very slight, and the fire insurance offices cover the damage done to property insured. It has sometimes been suggested that science should devise a means of making coal-gas less offensive to the sense of smell. It is well that this has never been done, or the danger from its use would have been ten times increased. Seeing that the manufacture of gas for the purposes of our great towns is frequently carried on in thickly populated neighbourhoods, it is fortunate that no great catastrophe has occurred. I mark a few of the more prominent explosions :—

Table H.—Gas Explosions of Serious Magnitude.

1841.	Dec. 16	...Gasholder at Dundee Gas-works; 2 persons killed, and much property in the neighbourhood damaged.
1853.	Jan. ?	...The new gasholder at Chatham.
1858.	Sept. 13	...Explosion at Sheffield Music-hall; 4 persons killed in endeavouring to escape from hall.
1865.	Oct. 31	...Gasholder at works of London Gas Company, Nine Elms; 10 workmen killed, and great destruction of property.
1876.	Aug.	...On board ship *Atalanta*, Cardiff. The ship was loaded with 1,400 tons of steam coal, and the hatches were kept down; gas accumulated, and coming into contact with a lighted match, struck by the second mate, exploded, killing 4 men, and greatly damaging the ship. A Board of Trade inquiry was instituted. (See result at end of table.)
1878.	Mar. 8	......Gasoline Gas Machine exploded in Town-hall, Harrison, Ohio; much damage.
	June 6	...On board steamer, *Chrysolite*, in the Alexandra Dock, Newport (Monmouthshire); 4 killed and 7 wounded; side of ship blown out.
	June 29	...At Cardiff, on board *Caduceus*, a steamer, loading with 2,300 tons of steam coal, for Aden. 6 men were loading, when one lowered a light that the others might see better, and explosion resulted.
	Oct. 11	...Extensive explosion at Linesey Cotton Mill, Blackburn; a great number of the work-people injured, and stock of cotton fired.
1879.	Jan. 6	......Three, more or less, serious gas explosions in different parts of London.
	April 14	...At Vigo, on board the British steamer, *Streonshath*, from Newport, for Savona, laden with coals.
	May 20	...At Cardiff, on board Genoese brig, *Santina Ansaldo*, laden with small coal for Leghorn.
	June 6	......At Sittingbourne Gas Works, doing considerable damage. It occurred in the "Governor-house," and was attributed to failure of apparatus.
1880.	Jan. 3	......At Plymouth, in a circus; considerable destruction.
	April	......An experimental military balloon, at Meudon (France); attributed to the effect of the high external temperature on the gas in the balloon.
	April 13	...At St. Martin's Church, Bradley, near Wolverhampton; organ destroyed, stained glass windows broken, and fabric partly destroyed.
	July 5	......Tottenham-court-road, London; capacious newly-laid gas mains, filled by leakage from old mains, exploded, causing considerable damage to persons and property, tearing up the road, and continuing to explode every few hundred yards along Bayley-street, Rathbone-place, and Charlotte-street.
1880.	July 13	...At Bilston (Staffordshire), an explosion in the streets, the sewers having been filled with gas; followed by a second and more serious explosion. The road torn up for some hundreds of yards.
	Aug. 9	......Remarkable explosion of a street lamp near Ludgate-hill, the flame extending down the pipes towards the main; but the mischief was arrested at an early stage.
1881.	Feb. 3	......At Sheffield; great damage to stock in large drapery establishment.

It is seen from the preceding table that the risk to shipping engaged in the carrying of steam coal is very considerable. After the explosion on the *Atalanta*, in 1876, a Board of Trade inquiry was held, and a report issued, the conclusion of which was as follows:—

"The Court is of opinion that a cargo of coal of this description, so especially liable to generate gas, should be ventilated by tubes fore and aft reaching to the underside of the deck, but not extending below the surface of the cargo, and having sufficient elevation above the deck to be out of the reach of fire, fitted with revolving cowls so as to create a thorough draught of air fore and aft above the cargo, by which means the accumulating gas would be continuously swept away. And in no case should a vessel loaded with coal be allowed to proceed to sea depending upon its hatches only for ventilation."

Gunpowder.

This explosive compound has been in use now for something over five centuries, and its influence upon the destinies of mankind has been very considerable—perhaps greater than those resulting from any other single invention, save the printing-press. Its direct mission was to war against the human race, and it has done so even to a greater degree than could have been foreseen. Here I have only to regard it in the light of its accidental, and not of its intentional, destructiveness; and so regarded, it falls into a degree of minor importance. Yet, in regard to the immediate subject of explosions, it occupies still a prominent place.

The City of London, in its Fire Ordinance of 1667, enacted as follows:—

"xxvii. *Item.*—That no gunpowder be kept within the walls of the City (except as aforesaid) but in such secure places as shall be allowed and approved by the Court of Aldermen."

The exception related to the storing of gunpowder to be ready for the blowing-up of buildings in case of fire, the Great Fire of 1666 having been so stayed. That it was frequently employed in this manner at subsequent fires there is good ground for believing. The poet Gay, in his "Trivia, or the Art of Walking the Streets," written in 1715, makes pointed reference to the practice, which, while the houses were mostly built of wood, no doubt had advantages.

> "Hark! the drum thunders; far, ye crowds retire;
> Behold the ready match is tipt with fire;
> The nitrous store is laid; the smutty train,
> With running blaze, awakes the barrelled grain.
> Flames sudden wrap the walls; with sullen sound
> The shattered pile sinks on the smoky ground.
>
> —*Book III.*

That gunpowder is capable of being employed for useful purposes, is truly a set-off against the many evils it has produced. In its application to the purposes of blasting in metal and coal mines it has led to many disasters. But in respect of large

engineering works, such as the removal of the Round-down Cliff at Dover, 19th September, 1850; the removal of a dangerous portion of the Undercliff, Isle of Wight, a few years later; its more recent use in opening for navigation, Hell-gate, East River, New York—where another great operation, by its aid, is still pending—it has been of real service. Yet, on the other side—that of wanton destruction of property—there is a sadly dark record; as witness a table given in a later portion of this paper, "Wilful Damage."

Table I.—Explosions of Gunpowder from Earliest Records down to Present Time in Various Parts of the World; cause being stated where practicable.

1568. ...Gunpowder magazine at Londonderry; great damage.

1569. ...Venice—fire at the arsenal; explosion followed, reducing city to ruins.

1654. ...Magazine at Gravelines; about 3,000 people killed.

1693. ...At Dublin, 218 barrels exploded, killing about 100 men.

1697. Oct. 27 ...Athlone, Ireland, great storm; lightning struck castle, and exploded powder magazine.

1739. Sept. 10 ...At Bremen, by which about 1,000 houses were destroyed, and 40 persons killed.

1753. ...France—some mules employed to carry gunpowder to Niort, stopping near Pilori, in Poictiers, and being incommoded by flies, stamped upon a pavement of some flints, and thus ignited some grains which had dropped from the bags they were carrying. A terrific explosion followed, not only destroying the mules and their drivers, but throwing down houses, and committing other devastation.

1758. Mar. 11, Aug. 6, Dec. 29 } Three serious explosions at the Hounslow Mills.

1762. Aug. 11 ...The city of Worcester was greatly damaged by a gunpowder explosion.

Oct. 15 ...Goree nearly destroyed.

1765. Dec. 3......Two mills blown up at Waltham.

1767. Jan. 1......The Royal Mills at Faversham blown up.

1768. April 13...Italy—powder magazine at Crema; the town ignited.

May 10 ...An explosion at Ewell Mills destroyed property valued at £8,000.

1769. Aug. 18 ...Powder magazine at Brescia, caused by lightning; about 3,000 deaths.

...About the same date a magazine at Venice, by lightning; 400 killed.

1770. Sept. 1 ...Faversham Powder Mills.

Sept. 27 ...Hounslow Powder Mills.

1771. Sept. 18 ...At Moulsey; 3 men killed.

1772. Jan. 6......Three mills blown up at Hounslow.

Nov. 5 ...At Chester, destroyed many spectators at a puppet-show, and greatly damaged many houses.

1773. ...At Chamberry; 18 persons killed, and several houses destroyed.

Nov. ...Abbeville nearly destroyed; 150 inhabitants perished, 100 houses destroyed.

...Trichinopoli blown up; 300 inhabitants lost their lives, 340,000 ball cartridges were destroyed, and the whole foundations shaken.

1774. April 24 ...At Hounslow; 2 persons killed.

1776. Aug. 20 ...At Picardy.

1777. Aug. 16 ...Epsom Mills were blown up.

1779. June 26 ...Vienna received great damage, and several lives were lost.

Sept. ...Civita Vecchia nearly destroyed.

1780. Aug. 18 ...Malaga gunpowder magazine; lightning.

1782. Mar. ...Sumatra gunpowder magazine; lightning.

1783. April 10 ...Benwolen magazine and laboratory; lightning.

1785. May ...Tangiers gunpowder magazine; lightning.

1789. Mar. 11 ...A magazine destroyed by fire at Corfu; 72,000 lbs. of powder and 600 bombshells blew up; 180 men killed.

Oct. 3......Faversham Powder Mills.

1790. Oct. 12 ...Dartford Mills; 6 men killed; great destruction of property.

1791. July 5......Ewell Powder Mills.

1792. June 28 ...At Lubin, in Poland, the axle-tree of a carriage conveying powder to the army took fire, and destroyed a great number of houses and some public buildings; about 90 persons were killed and wounded.

1793. July 10 ...At Bayonne, the chapel at the new castle was blown up, and 100 lives destroyed.

Sept. ...The barracks at Youghall blown up.

1794. Sept. 3 ...Powder mills at Grenelle, near Paris, exploded; near 3,000 persons lost their lives, and all adjacent buildings were destroyed.

Dec. 20 ...Landau had its arsenal blown up.

Dec. 31 ...Dartford Mills; 11 men killed.

1796. Jan. 14 ...Hounslow Mills; 3 men killed; great destruction of property.

Aug. 10 ...At Dartford; 4 persons killed.

1798. May 20 ...Battle Mills; 3 killed, and great destruction of property.

1799. Jan. 14 ...At Dartford; 3 persons killed.

July 13 ...At a mill on Twickenham-common; 4 men killed.

1800. May 28 ...A powder magazine at Nantes blew up, destroying many persons and houses.

1801. Mar. 20 ...Battle Mills; 1 man killed.

1801. April 25...Waltham Mills; 9 men killed.

1802. Sept. 8 ...Faversham Mills; 6 men and 3 horses killed.

1805. June 15 ...At Dartford; 2 men killed.

Oct. 1 ......Powder mill, Roslin, near Edinburgh; 2 killed.

1807. Jan. ....A vessel lying in the Rapenberg Canal, Leyden, blew up, and destroyed the best-built portion of this interesting city.

June 26 ...Powder magazine at Luxemburg; lightning.

Sept. 18 ...Faversham Mills; 6 men and 3 horses killed.

1808. Sept. 9......Powder magazine at Venice; lighting.

1810. Jan. 16 ...Faversham Mills; 5 men, a boy, and some horses killed.

Sept. 2......Eisenbach; 3 French powder wagons blown up; 54 lives and escort, with 28 houses destroyed.

Sept. 24 ...Dartford Mills; 2 men killed.

1811. Nov. 27 ...The Walthham Mills blown up; 7 men killed.

1812. July 4......At Hounslow; 2 men wounded.

July 14 ...Roslin Mills, near Edinburgh, blown up; 2 men killed.

1813. Aug. 21 ...Two explosions at Hounslow Mills; 3 workmen killed.

1814. Sept. ......Battle Mills; 3 men killed.

1816. April 16 ...Toulouse Powder Mills; 16 killed, others wounded.

1817. Oct. 3 ......Faversham Mills; 3 men killed.

1818. Mar. 19 ...Powder Mills at Brandy-Wine, U.S.; 30 killed, many wounded.

1829. Nov. 28 ...Powder magazine at Navarino; lightning.

1837. Aug. 23 ...Powder-laden lighter off East Greenwich, causing considerable damage to persons and property.

1838. Oct. 8 ......Hall's mills, Faversham; 4 persons killed.

1840. June 6......Powder magazine at Bombay; lightning.

...Also, about same date, Dum Dum.

1843. April 13...Waltham Mills; 7 men killed, and buildings destroyed.

April 22 ...Powder magazine at Puzzaloni, Sicily; lightning.

April 23 ...Powder magazine at Gaucin, Spain; lightning.

1845. March 8...Algiers; two magazines, killing 43 workmen, 10 artillerymen, and 31 pontonniers.

1850. Mar. 11 ...Three explosions at Hounslow Mills; 8 persons killed.

Sept. 29 ...The *Donna Maria*, Portuguese frigate, blown up at Macao, when firing a salute in honour of the Prince Consort; 200 men and boys reported to have perished.

Oct. 13 ...The *Abdul Medjid*, Turkish line of battle ship, blown up in Bosphorous; about 500 killed.

May 1 ......Fleet of powder-laden boats at Benares, causing death of 420 persons on the spot, and injuring over 800 others.

1851. April 3 ...Powder magazine at Tremesvar, Hungary.

...At Hounslow Mills; lightning.

1853. Aug. 17 ...Powder magazine at Gibraltar; 5 men killed, 1 injured.

1855. Nov. 6......Powder magazine, Rhodes; lightning; 300 lives, and 400 houses destroyed.

Nov. 15 ...French magazine at the Crimea, containing large quantities of munitions of attack; which also exploded English magazine; 53 killed and many hundreds wounded.

1856. Mar. 7......Hatton Powder Mills, Hounslow; 3 lives lost; caused by sparks from lamp.

Nov. 6......Powder magazine at Rhodes; lightning.

1857. Aug. 10 ...Powder magazine at Joudpore, Bombay; lightning; 1,000 killed.

1859. Mar. 30 ...Hounslow Mills blew up; loss of 7 lives.

Aug. 6......Ballincolig Mills, near Cork, blew up; 5 persons killed. (See 1861.)

1860. Sept. 10...Melford Powder Works, Argyleshire; 6 men killed; 3 tons of powder.

Dec. 1......In shop at Norwich; 2 persons killed, and much property destroyed.

1861. May 27 ...Waltham Mills blew up; 1 killed, and many others wounded.

Oct. 24 ...Powder mills, Ballincolig, Cork; 5 persons killed.

1862. Sept. 9 ...Nancy Kuke Powder Mills, Cornwall; 6 women killed.

1864. Jan. 9......The *Lottie Sleigh* exploded in the Mersey, at Liverpool, in consequence of fire on vessel, caused by oil cans igniting; great damage to property.

Oct. 1 ......At Erith, Messrs. Hall's magazine, 100,000 lbs. of powder; 10 men killed, and property damaged for many miles round.

1864. Dec. 9......Powder store at Buenos Ayres exploded, killing 160 soldiers.
Dec. 24 ...A powder vessel exploded at Wilmington, U.S., without other damage.
1865. Mar. 29 ...Faversham Mills; 2 persons injured.
April 11 ...Four or five barrels of powder exploded in a shop in Southwark.
May 24 ...At Mobile, U.S.; about 300 persons killed.
Sept. 25 ...Ewell Mills; 2 men killed.
1867. Dec. 28 ...Faversham Mills; 11 men killed, and much damage done; shock felt at Canterbury, 10 miles off.
1868. Dec. 21 ...Another at Faversham Mills; 5 killed, 4 injured.
1869. June 19 ...Hounslow Powder Mills; 4 persons killed.
Oct. 19 ...Black Beck Mills, Windermere; 3 persons killed.
Dec. 17 ...Hounslow Mills; 3 persons killed.
1870. Mar. 11 ...Kaimes' Powder Mill, Rothesay; 5 workmen killed, and serious injury to buildings.
1871. Feb. 5......Powder wagon on railway between Bardoz and St. Nazaire; 60 persons killed, and about 100 others injured.
Feb. 6......Dunkirk Powder Magazine; about 60 lives lost; caused by careless use of lucifer matches.
Mar. 2 ...Powder arsenal, Morges; 20 soldiers killed.
1872. Feb. 5......Hall's Powder Works, Faversham; 2 killed, 2 injured.
May 23 ...Roslin Powder Mills, near Edinburgh; several killed.
May 30 ...Powder magazine, Porthywain Lime Rocks, near Oswestry; 6 killed.
Sept. 6 ...Hounslow Mills; 3 lives lost.
1874. Jan. 7......Carthagena powder magazine.
Oct. 2......The barge *Tilbury*, on the Regent's-canal, laden with 4 tons of blasting powder and 6 barrels of petroleum. The latter, it was believed, ignited and fired the powder. Exploded near North-lodge, Regent's-park, killing 3 persons, and doing vast damage to property.
Nov. 3 ...Hounslow Mills; 4 killed. 2 injured.
1875. July 16 ...Hounslow Mills; considerable destruction of property; no lives lost.
Aug. 17 ...At Barcelona, the Spanish steamer *Express* was loading with war material, and exploded; 50 lives lost.
1876. April 22 ...In a railway tunnel at Cymner, near Heath; 13 excavators killed.
July 1 ......Hounslow Mills; workmen had left premises.
1877. May 6......Powder mill at Schulau, near Blankenese (Hamburg); effects very violent; 20 killed, and much property destroyed.
July 12 ...Powder manufactory at Okta, near St. Petersburg; 6 killed, and many wounded; fire followed, and much damage was done to property.
July 30 ...Floating magazine on Thames; 3 killed.
Oct. 6 ......Powder factory at Térguschoff, Plojesti, Austria, with immense stores; 16 killed and many wounded.
1878. March 31...At Marsh Works Powder Factory; "green charge."
Nov. 29 ...Powder mill, Elterwater, near Ambleside, Westmoreland; 3 killed, 1 injured. [I quote from official report hereon in note below.]
1879. Feb. 10 ...Chilworth Mills, near Guildford; 2 killed.
Feb. 21 ...Messrs. Hill's Mills, Faversham; 1 killed, and immense destruction of property.
March 1 ...At Dalry, Ayrshire; powder for mining purposes.
1880. Jan 3.......On a gunsmith's premises, at Doncaster.
April 7.....Halton Mills, Hounslow; no lives, but considerable damage.
May 8.......At Rothweil Powder Factory, Geesthacht, near Hamburg; 4 killed.
At Worsborough Powder Mills, near Barnsley; men not allowed in mill while machinery at work; considerable destruction of property.
Dec. 11.....At Marsh Mills, Faversham; in the testing-house, which was closed; shock very violent.
1881. Mar. 19....At Blackbeck Powder Mills, High Furness; 2 loud explosions; 3 killed.

Note.—The report of Major Ford, R.A., one of H.M.'s Inspectors of Explosives, on the Elterwater explosion, 29th Nov., 1878, contained the following passage:—"One lesson, at any rate, may be learnt from this accident—namely, that active supervision in matters of detail of foremen in gunpowder factories cannot be dispensed with. Such a system as was found to be in force at this factory ought to be impossible. . . . Better supervision on the part of the manager would have insured the observance of the special rule, which was, as it appears, habitually disregarded. It also appears that, where access can be obtained to a factory during the absence of the men, it would certainly be advisable not to leave the keys of the powder buildings where anyone who has been employed about the place can obtain them. Lastly, the great value of trees as a screen to powder buildings is again forcibly illustrated. Large pieces of burning wood are very likely to be caught by tall trees, and even a small branch is sometimes sufficient to stop tiles and slates."

The annual value of gunpowder exported from this country as an article of commerce, is about £300,000.

It is seen that a considerable number of the explosions enumerated in this table were caused by lightning. I do not think it must be regarded from this fact that powder magazines present any particular or peculiar attractions to the electric fluid, although it may be thought that the chemical compounds there collected may do so. I believe the real fact to be that the situation of the powder mills affords an entire solution of the problem. They are mostly located on marsh lands near rivers, where there are few buildings, and the electric fluid may be attracted by moisture and drawn towards their localities. Ice-houses are struck with lightning in a like manner, and from, I believe, the same cause; but on this point I hear there is some difference of opinion. It cannot be contended that there is any other resemblance between powder mills and ice houses.

Metal Mines.

The metal mines of this country distinguished from the coal mines) suffer very slightly from fire-damp, and explosions consequent thereupon. In the 18 years, 1861-78, there have been only 54 deaths from this cause in these mines, viz., 1 in Derbyshire district, 2 in the Yorkshire district, 2 in Monmouthshire district, 18 in North Staffordshire, Cheshire, and Shropshire, 17 in South Staffordshire and Worcestershire, 3 in the East Scotland district, and 11 in West Scotland.

Mineral Oils.

Another important element in this increase of explosions during the present generation arises in the use of mineral oils, chiefly petroleum and its products. This oil came rapidly into use on account of its comparative cheapness after its discovery, in 1859-61, in Canada, and in the coal regions of Pennsylvania. In its crude state it is inflammable at a very low temperature, and much mischief has resulted in consequence. There is now a Petroleum Association, which tests the quality for the purposes of commerce and public safety. The individual catastrophes may be counted by the hundred, and even by the thousand, but the larger ones traceable to explosions are not numerous; and yet probably nearly all the large conflagrations laid to its charge have really originated in explosions.

Table J.—Serious Explosions resulting from Mineral Oils.

1868. Dec. 13 ...Three Bridges Railway Station; 2 railway guards killed.
1869. Oct. 28 .. Bordeaux Harbour; 16 vessels destroyed, and many others injured.
1871. July 16 .. Manufactory, near Rheims; about 50 killed.
Oct. 4 ..... Chelsea.—Triple explosion at oil and colourman's, Manor-street, King's-road.
Oct. 16......Erith.—The brigantine *Ruth* blown up; 2,000 barrels of petroleum, 100 of resin on board.
1874. Oct. 2 ......Regent's Canal.—The explosion of gunpowder on board the *Tilbury* was believed to have been occasioned by the vapour given off by the petroleum on board. (See Table L.)
1878. July ...Petroleum factory at Lyons; 30 persons injured.
1880. June 4 ....Terrific conflagration caused by lightning at Titusville, Penn; 320,000 barrels of petroleum destroyed, and large portion of town.

Note.—Many great conflagrations have occurred in the oil tanks at "Petrolia" and elsewhere, from the influence of lightning acting upon the vapour.

The safe keeping of petroleum is now regulated by Acts of Parliament, enacted in 1862, 1868, and 1871 respectively. The supply of the oil has shown some indications of falling off in the United States, but new sources of supply are opening up in Bohemia and elsewhere.

STEAM BOILERS.

Next, I come to notice the explosions of steam boilers. The gradual but now general introduction of steam into our locomotive appliances, as into our manufacturing operations, during the present century, I have already noticed. Boilers may be divided into four great classes :—1. Marine; 2. Manufacturing; 3. Locomotive; 4. Domestic. And in each instance they need to be managed by those who understand their construction and requirements. The great majority of casualties—and these have been in the past, if they are not now, of alarming frequency—arise from ignorance or negligence.

I have endeavoured to frame an estimate of the number of steam boilers of each class in use in this country, but hitherto without success. The number presents a very large aggregate. The evidence given before the Select Parliamentary Committee, 1871, to inquire into the causes of boiler explosions (in continuation of the labours of a like committee appointed in 1870) pointed to a belief that there were not less than 100,000 steam boilers—exclusive of those of locomotive engines, steamships, and domestic and hot-house boilers—in the United Kingdom at that date. An estimate I had prepared fully confirmed this view.

TABLE K.—THE MORE SERIOUS EXPLOSIONS OF STEAM BOILERS OF THE VARIOUS CLASSES DURING THE PRESENT GENERATION :—

1838. Mar. 16....Marine boiler on board the *Victoria*, of Hull, on experimental trip from London to the Nore; 3 killed.
1841. Oct. 13.....Machine works of Messrs. Elice, Manchester; 6 killed and many injured; also much property destroyed.
1842. Mar. 21.....*Telegraph*, high-pressure steamer, at Helensburgh pier, N.B.
Nov. 18....Bolckow's Iron Works, Middlesboro; 4 killed, and 20 injured.
1845. Mar. 5......Mr. Samuda's Works, Blackwall; 3 killed outright, and many wounded, some of whom subsequently died.
1847. Sept. 25....*Cricket* steam-boat, at Hungerford-bridge; 6 killed, and 12 seriously injured.
1848. July 31.....Lambert Bottom Mills, Preston; 7 killed.
1850. Feb. 6. ...Printing-office, Hogue-street, New York, causing destruction of entire building—six storeys; 30 killed.
July 21. ...*Red Rover*, at Bristol; 6 passengers killed, and nearly all on board injured.
Nov. 8. ...French war-ship *Valmy*, blown up in Torbay; 20 killed.
1851. Feb. 5. ...*Plover*, exploded while getting up steam in Glasgow Harbour.
March 17..Marsland's Cotton Factory, Stockport; 20 killed.
Nov. 5. ...Steam tug at Conham Ferry, near Bristol.
1853. June 2. ...*Times*, screw steamer, Dublin Harbour; 12 killed, 10 of whom were passengers.
1854. July 2. ...Williamson's Calico Factory, Rochdale; 10 killed. Inexperienced persons getting up steam.
1855. Oct. 9.......Walker's Ironworks, Newcastle; 6 killed and many injured.
1857. Dec. 23 ...Upper Apsley Mill, Huddersfield; 8 killed, and many injured.
1859. Feb. 22. ...*Black Eagle* steam-tug, in Cardiff Dock; 5 killed
April 15...Edwards's Spinning Mills, Dundee; 19 killed. and 14 injured. Building destroyed.
Sept. 21....Portable steam-engine, at Lewes Agricultural Show; 5 killed and many injured.
1860. Nov. 3......ss *Tonning* in Yarmouth Roads; 11 killed, and great loss of live stock, forming cargo.
1861. Jan. 5......Portable threshing machine in Langton (Yorks); 2 killed and 6 injured.
1862. April 15...Millfield Ironworks, Priestfield, Staffordshire; 28 killed and 10 injured. Three-fourths of the boiler, weighing about 8 tons, was thrown from to 200 to 300 feet in the air, and in falling caused destruction of property.
Nov. 8......Locomotive engine, "Perseus," in engine shed of Great Western Railway; 2 killed, and much damage.
Dec. 3......Midland Ironworks, Masboro' (Yorks); 9 killed, and many injured.
1863. March 8...Moss End Ironworks, near Glasgow; great destruction of life and property.
1864. Feb. 17 ...Aberaman Ironworks, South Wales, 13 killed, many injured.
1865. June 7......Brewery in Burton; 2 killed, 5 injured.
1867. Dec. 29 ...The Greek war steamer, *Bubulino*, blown to pieces; some killed, and many injured.
1868. Sept. 27 ...Moxley Steel and Ironworks, Wolverhampton; 11 killed, and many injured.
Oct. 2 ......Elsecar Ironworks, Newcastle; several killed.
1869. Feb. 21.....Austrian frigate, *Radetzky*, blown up off Lima; 380 killed.
June 9 .....Bingley, near Bradford, boiler in manufacturing premises; killing 9 children at play on ground adjoining the works.
Aug. 11....Steam-tug, off Custom-house Quay, Thames; 3 killed.
14....Steamer *Cumberland*, Ohio River; 20 killed.
Oct. .....Bramley's Iron Foundry, Accrington; 5 killed.
Nov. 3......The *Thistle*, at Sheerness; 10 killed.
Dec. 2......A screw steam-lighter; all on board killed.
3......Britannia Iron Works, Wloverhampton; 8 killed.
1870. April 20 ...Locomotive at Warrington; 5 killed.
May 26.....Cleugh-hall Iron Works, Staffordshire; 4 killed and 9 injured.
1872. April 11 ...Steamer *Oceanus*, on Mississippi; 6 killed.
1873. Nov. 22....Cameron's Engineering Works, Glaswow; 4 killed.
1874. Mar. 2......Alderman Thompson's Spinning Mills, Blackburn; 12 killed; 20 injured.
1876. Mar. 28....Locomotive in ballast train, between Kilmarnoch and Irvine; 4 killed, 9 injured.
July 14....On board H.M. iron-clad turret-ship *Thunderer*, one of the boilers; 38 killed, and many seriously injured.
1878. April 8....On board steamer *Orion*, in River Schelde; 1 killed.
27...Messrs. Strong's Ironworks, Dublin; 16 killed.
1879. Mar. 19....Harthill pit, Linlithgowshire; 6 boilers said to have exploded simultaneously; 3 killed, with great destruction of property; chimney shaft, 100 ft. high, knocked down.
May 13.....Walsall District Iron Works; 5 killed and some wounded.
June 29....Steamer *Black Swan*, in Yarmouth Roads.
Oct. 6......Messrs. Balm and Pritchards, Halifax; 6 killed.
1880. Jan. 27.....On board steam-ship *Jones Brothers*, of Newport, at Bilbao; 3 killed.
Mar. .....Glasgow Iron Works; 25 killed, and many injured.
May 15.....Birchill's-hall Iron Works, Walsall; 25 killed, and many seriously injured.
29.....Boiler at Gunpowder Factory, Weteren, near Ghent; 7 killed.
June 6 ...Vivian Copper Works, Swansea; one of the men blown into a tank of molten metal.
July 20 ...On board the *St. Oswin*, at Gibraltar; 3 killed.
Oct. 27 ...Balfron Iron Works, near Dunfermline; 1 killed.
Nov. 20 ...New British Iron Company's Works, Acrefail, near Ruabon; 4 killed.
1881. Jan. 19....Providence Mill, near Batley (Yorks.); 11 killed.

A noticeable feature in the foregoing table—which must be regarded as illustrative only—is the large proportion of boilers which have exploded at iron-works. One of two things seems certain, either that inferior boilers are too often used on such works, unequal to the pressure required, or that the jarring of the rolling-mill or the steam-hammer produces mischief to the boilers or their setting, and so deteriorates them more rapidly than elsewhere.

With regard to marine boilers, happily an explosion of these is now an increasingly rare occurrence. The very idea of such a catastrophe at sea is terrible to contemplate. The Board of Trade regulations as to inspection and working have been most efficacious.

As to the boilers employed in our great manu-

facturing industries, the advent of the Steam Boiler Inspection Association (in 1855*), and still more that of the Steam Boiler Insurance Companies, the first of which was that founded in Manchester in 1858, with Mr. R. B. Longridge as its chief engineer. When I made the calculations upon which the rates of this company were based, I hardly foresaw to the full extent the benefit which would result, from periodical inspection, in the way of prevention of accidents. By the end of the year 1860 the company had received proposals for the insurance of 3,149 boilers. Other boiler insurance companies followed, notably the Midland Company at Wolverhampton (in 1862), with Mr. E. Binden Marten as its chief engineer. In collecting the data for the calculation of rates and estimation of risks, in connection with this company, I obtained a considerable insight into the boilers in use in the Staffordshire iron districts, and certainly formed an unfavourable opinion of many of these.

By the end of 1868 the number of boilers under protection of the different boiler insurance companies was found to be as follows: —

1. Boiler Insurance and Steam Power Company (1858)	10,900
2. Midland Steam Boiler Protection and Assurance Company (1862)	2,600
3. Association for Prevention of Steam Boiler Explosions (Manchester, 1855-64)	1,900
4. Nation Boiler Insurance Company, Limited (1864)	2,000
Total	17,400

An estimate was then made that in the United Kingdom during the preceding ten years there had been 495 boiler explosions, by which 786 persons had lost their lives, and a yet greater number had sustained serious injuries. The annual explosions were estimated at 50, causing 80 deaths. Out of 16,411 boilers insured by the Boiler Insurance Company only 15 had exploded, being less than one per 1,000. The number of inspections made by the officers of the above insurance company in 1868 was 65,440, showing an average of nearly four inspections per boiler per annum.

The value of periodical inspection of boilers cannot be over-rated; and the practice has been largely extended by the insurance companies. The inspectors of the Boiler Company (Manchester), made, in 1878, no less than 79,423 inspections, of which 67,208 were ordinary examinations; 1,215 were internal examinations; and 11,000 were thorough examinations—the last two involving stoppage of the works for the purpose. And their value is at once seen in the return of the various defects reported to the owners of the boilers examined, as follows:—

Corrosion of plates and angle iron	1,825
Fracture of plates and angle iron	443
Safety-valves out of order, or over-loaded	1,896
Pressure gauges out of order	744
Water gauges out of order, or fixed too low	360
Boilers damaged from over-heating, owing to accumulation of deposit	21
Boilers damaged in consequence of deficiency of water	69
Total	5,358

—all trivial defects being omitted from this enumeration.

While no complete returns have heretofore been kept of boiler explosions, the insurance companies engaged in the business have kept registers of such explosions over a series of years; and although admittedly incomplete, they are still interesting and even valuable, as far as they go. The following Table, going back more than half a century before boiler insurance was commenced, has been compiled by Mr. E. B. Marten, and kindly placed at my disposal, with many other facts—some of which I cannot now use—for the purposes of the present paper.

Table L.—Showing approximately the Number of Steam-boiler Explosions in the United Kingdom, and the Loss of Life and Injury resulting, during the period 1800—80.

Year.	No.	Killed.	Injured.	Total Killed and Injured.
Unknown	1	0	0	—
1800—1809	1	3	5	8
1810—1814	5	10	3	13
1815—1820	7	42	33	75
1821—1825	3	8	0	8
1826	1	0	16	16
1827	5	19	0	19
1828	2	0	0	—
1829	2	1	5	6
1830	3	15	57	72
1831	3	8	10	18
1832	7	14	11	25
1833	0	0	0	—
1834	0	0	0	—
1835	3	1	0	1
1836	3	10	8	18
1837	2	1	0	1
1838	16	24	30	54
1839	5	4	2	6
1840	3	4	6	10
1841	7	10	33	43
1842	8	40	23	63
1843	12	0	24	24
1844	8	22	6	28
1845	18	36	100	136
1846	11	25	26	51
1847	17	19	64	83
1848	9	41	23	64
1849	11	12	33	45
1850	13	31	42	73
1851	14	58	23	81
1852	10	17	17	34
1853	18	35	95	130
1854	15	36	34	70
1855	35	38	55	93
1856	33	66	105	175
1857	37	80	57	137
1858	34	50	89	139
1859	39	75	71	146
1860	35	78	82	160
1861	30	46	42	88
1862	36	91	69	160
1863	51	79	78	157
1864	51	67	116	183
1865	58	50	92	142
1866	70	85	160	254
1867	48	70	88	158
1868	45	57	71	128
1869	59	87	128	215
1870	70	85	138	223
1871	66	66	113	179
1872	74	50	137	187
1873	88	66	94	160
1874	76	77	198	275
1875	68	81	142	223
1876	39	93	110	203
1877	44	54	75	129
1878	46	47	84	131
1879	30	38	53	91
1880	31	71	83	154
	1,536	2,293	3,259	5,552

* On 31st December, 1855, this association had 269 members owning 920 boilers; at the close of 1859, 538 owners, with 1,619 boilers; but immediately on the formation of the insurance company the business of this association fell off. In 1864 the association added on the business of insurance. A similar inspection association had been founded at Huddersfield in 1858.

The fluctuations in the annual number of explosions are somewhat considerable, but this may arise from the imperfection of the records; yet it seems to have been more influenced by the state of trade, at least in the last two decades. This is shown in a very striking degree in a comparison of the years 1866-7; and in a less striking degree in 1874-5, compared with later years.

The number of boilers insured, and, therefore, under inspection, in the United Kingdom, is believed to be from 40,000 to 50,000. The actual number of explosions during the last 19 years, as recorded by Mr. Marten, up to end of 1880, is 1,047—being an average of just over 55 per annum; and, what is even worse, giving a mortality of killed, 1,324; injured, 2,026—total, 3,350. Of the property injured by the explosions, no record seems to have been kept; but taking the boilers as being of the value of £100 each at the time of the explosion—which is certainly an under-estimate—we have an aggregate of £104,700, and this is not including cost of "setting" and fittings, to say nothing of loss of time by stoppage of works. Assuming that the average loss all round is £500 in respect to each boiler explosion, we thus have an annual loss of £27,500, to say nothing of the loss of life; but I feel sure that we shall be told to-night that this is entirely an under-estimate.

Mr. R. Charles Longridge, of the Engine-boiler and Employers' Liability Insurance Company (Manchester), has kindly sent me the following statement, which, from a mechanical point of view, is of much interest, and some value:—

Summary showing the Numbers of different kinds of Boilers which have exploded during the last 19 years, and the Causes of the Explosions, classified under the following heads, viz.:—

A. Bad design, workmanship, or material.
B. Defects arising in course of use.
C. Ignorance or carelessness of attendants.
X. Causes extraneous or not ascertained.

Type of Boiler.	A.	B.	C.	X.	Total.	Per-centages.
Cornish and Lancashire	124	115	112	6	357	34·1
Plain Cylindrical	106	62	67	7	242	23·1
Locomotive and Agricultural	32	44	31	16	123	11·7
Marine	16	26	21	8	71	6·8
Vertical and Crane	10	8	25	2	45	4·3
Balloon, Wagon, &c.	19	9	16	—	44	4·2
Domestic	4	1	37	—	42	4·1
Rag Boilers, Kiers, &c.	17	1	9	8	35	3·3
Furnace	10	9	14	1	34	3·2
Tubulous & Economisers	9	2	10	5	26	2·5
Uncertain	—	—	—	28	28	2·7
Totals	347	277	342	81	1,047	
Per-centages of Causes	33·14	26·47	32·66	7·73		

Note by Mr. Longridge.—The above particulars are summarised from the Tables of Explosions published by Mr. E. B. Marten, of Stourbridge.

In many cases, the actual cause of the explosion is never satisfactorily ascertained. But another test of some practical interest may be applied, viz., the nature of the works wherein the exploded boilers were employed. I will take two years by way of example:—

1864.

Works.	No. of Explosions.	No. of Killed.
	Boilers.	Lives.
Iron works and foundries	9	32
Coal and other mines	9	11
Locomotive	6	4
Agricultural engine	1	1
Steamboat	2	7
Corn mill	2	6
Saw mill	2	1
Flax mill	1	1
Silk mill	1	1
Bleachworks	1	7
Chemical works	1	0
Cement works, flint mill, brickyard	3	0
House	3	3
Boilers for other purposes	2	0
	43	74

1878.

Works.	No. of Explosions.	No. of Killed.
Iron works	9	20
Collieries and mines	8	10
Steam vessels	7	7
Kitchens	7	2
Railways (Locomotive?)	4	0
Farms	3	1
Cotton mills	2	0
Flour mills	2	0
Flax mill	1	4
Woollen mill	1	3
Saw mill	1	1
Distillery	1	1
Paper mill	1	0
Waterworks	1	0
Chemical works	1	0
Brick works	1	0
Stone quarry	1	0
Picture frame works	1	0
	52	49

Iron works and mines in both years assert a most unsatisfactory monopoly. Steam vessels and locomotives are high, as also domestic or kitchen boilers. In 1864 there were no cotton mill boilers, in 1878 two.

In the matter of locomotive engines, great care in the construction and working have rendered explosions of very rare occurrence.

Domestic boilers in kitchen ranges are mostly under the control of those who have no mechanical knowledge, and too often but very limited powers of observation, and casualties are, therefore, to be expected. Mr. Samuel B. Goslin (a member of this Society) has published a useful little tract, "A Review of the Facts and Records in connection with Kitchen Boiler Explosions and Hot-water Boiler Explosions of 1881, with some Remarks upon their Prevention, and the Remedies."

There have been, from time to time, projects put forward for a Government inspection of steam boilers. This I conceive to be quite unnecessary, except in the case of marine boilers. The insurance companies do the work far more effectively and economically than it can be accomplished by any Government department. But in this connection, I may say I am glad to see before Parliament notice of a measure introduced by Mr. Hugh Mason, for enforcing better provisions regarding inquiries into cases of actual explosion. This is much needed. His Bill provides that, on the occurrence of an explo-

sion, notice of the various circumstances attending it should be sent within 24 hours to the Board of Trade by the owner or user. The maximum penalty for not complying with this direction is fixed at £20. The Board of Trade is thereupon authorised to appoint an engineer to make a preliminary inquiry; then, if it be deemed expedient, to have a formal investigation held by a Court consisting of two practical engineers and one competent lawyer, for the purposes of its investigations, the Court would have the powers of a Court of Summary Jurisdiction. Those who conduct these preliminary inquiries or formal investigations, are directed to report on the causes of the explosion and the circumstances attending it; and these reports are to be published by the Board. The Bill excludes from the scope of its operations all boilers used exclusively for domestic purposes, and those used in her Majesty's service, or on board steamships having certificates from the Board of Trade.

Boiler Insurance in United States.

In the United States, much attention is being paid to the subject of steam boiler explosions. Mr. J. M. Allen, the able president of the Hartford Steam Boiler Inspection and Insurance Company (established 1866), has founded, in the interest of that company, a publication, called the *Locomotive*, wherein all that relates to the subject is freely and fully discussed, and records of explosions are published. From its columns is prepared the following, otherwise almost incredible figures:—

Classification of Explosions which have been published in the "Locomotive" as having occurred between October 1, 1867, and January 1, 1880.

Kind of Works.	Number of Boilers Exploded.	Number of Persons Killed.	Number of Persons Injured.
1. Saw, planing, and wood-working mills	281	497	576
2. Steamboats, tugs, yachts, and steam barges	186	956	816
3. Railroad locomotives	185	249	238
4. Iron-works, furnaces, foundries, and machine shops	92	147	324
5. Paper, flouring, and grist mills, bleacheries, and print-works	92	96	122
6. Portable hoisting, threshing, and pile-drivers	66	143	137
7. Cotton, woollen, flax, and other fabric mills	55	72	131
8. Mines, quarries, oil-mills, and refineries	44	73	76
9. Heating and domestic boilers	29	10	33
10. Chemical, rendering, and slaughtering works	27	43	32
11. Distilleries, breweries, and sugar refineries	25	19	34
Miscellaneous—52 kinds not specified above	217	201	93
	1,299	2,506	2,612

In 1864, an Act was passed in the Pennsylvania Legislature, authorising the Mayor of Philadelphia to appoint a proper officer to inspect the steam-boilers in that city, without whose certificate no steam-engine or boiler should be put into use, with full power to enter upon premises, and order removal of buildings necessary for effective inspection. The deaths from explosions in the United States, during the year 1870, were returned as being 290.

Wilful Damage.—Diabolical Explosions.

An examination of my records shows that there are, unfortunately, sufficient of the "Diabolical Class," *i.e.*, wilful damage to life or property, to justify a special tabular enumeration. It is necessary to state here, as in the other tables, that the enumeration is not to be regarded as absolutely complete. It does not seem that this class of explosion has originated in the present age or century, but its recent development seems alike rapid and daring.

Table M.—Explosions Wilfully Caused in order to Damage Life or Property.

1645. .... "When the Swedish fleet, which had been laid up in winter quarters at Weimar, was preparing to leave that port in the spring of 1645, certain ambiguous utterances of a Pomeranian, called Hans Greff, brought him so much under suspicion that his house was searched, and in it were found two boxes, packed with all sorts of explosive and inflammable materials, in the midst of which had been concealed clockwork so arranged that 12 hours after being set going it must cause an explosion. Greff stated in his confession that certain persons in Lübeck had paid him to place these boxes, one in Admiral Wrangel's ship, the other in that commanded by Admiral-Lieutenant Blom—but he could not tell their names, and stringent investigation failed to discover these or any accomplices. He was accordingly burnt alive, and his infernal machines placed in the Arsenal, where they were to be seen as late as 1734."—Vide *Times*, 10th Jan., 1876.

1800. Dec. 24 ...The first Napoleon's life attempted with an infernal machine.

1835. July 28 ...Attempt by Fieschi upon the life of Louis-Philippe by an infernal machine, fired as he rode along the lines of the National Guard on the Boulevard du Temple. The machine consisted of 25 barrels, charged with various missiles, and lighted simultaneously by a train of gunpowder. The king and his sons escaped, but about 40 persons were killed, including officers of high rank, and many wounded.

1842. Nov. 14 ...Davison's Scythe-grinding Works, at Sheffield, blown up with gunpowder by workmen on strike.

1858. Jan. 14 ...Attempted assassination of Napoleon III. at the Opera, by the throwing of 3 shells; 2 persons killed, and many wounded. The attack was brought home to Orsini, Pieri, Rudio, Gomez, and others.

1867. Dec. 13 ...Attempt to blow up prison at Clerkenwell—Fenian outrage; 6 persons killed outright, and about 120 more on less seriously injured, besides much property destroyed.

1875. Dec. 11 ...At Bremerhaven, a man named Thomassen, consigned a cask of dynamite, to be conveyed to New York, by North German Lloyd steamer *Mosel*. With it he enclosed a clockwork machine, which would in 8 days give the cask a blow powerful enough to explode the dynamite, and, as a consequence, destroy the ship. From some cause the case exploded in the dock, killing over 80, and wounding about 200 persons, chiefly intending emigrants. He confessed his crime, and said he had conceived it only for the sake of obtaining the sum for which the case was insured. He committed suicide.

1876. May 4 ...A man, named Everett, attempted to destroy the store of Messrs. Baldwin and Co., New York, by placing an infernal machine under the stair-way. The machine consisted of a small box, filled with bottles of kerosene and gunpowder, with a lighted candle burning in the centre. The porter discovered the machine. The object was here, also, to obtain a few thousand dollars in respect of goods which he had consigned to Baldwin & Co., a few days' previously, and insured.

1879. March ...At Cracow; the explosion of a petard in front of the police-office.

1880. April ...Blowing up of Winter Palace in St. Petersburg; many killed and injured; much property damaged.

April 24 ...In the Casino. at Monte Carlo, a tin box, filled with gunpowder, had been placed under a large clock, which was exploded with a slow match; many injured.

Sept. 12 ...Explosive packages were placed on the main line of London and North-Western Railway, near Bushey, in view, it was supposed, of wrecking the Irish mail.

Nov. ...Explosive substance introduced into coal supply of engine attached to night mail to Liverpool and Manchester; much damage done to engine, but the train escaped destruction.

Dec. ..."At a ball at Schwarzenburg, Saxony, a young man entered, having what appeared to be a cigar in his mouth. He went to the chandelier as if to light it, and a terrible explosion ensued. The lights were extinguished, the walls partly gave way, dancers of both sexes were covered with blood, and the young man was blown to pieces. He had resolved on committing suicide, and had adopted a dynamite cartridge for that purpose."—*Times*, Dec 9, 1880.

Dec. 11 ...Explosion at Marsh Powder Mills, Faversham, caused wilfully; £500 reward offered.

1881. Mar. 13 ...The Emperor of Russia assassinated in St. Petersburg, by means of Orsini bombs:—"A French sailing vessel, the *Coralie*, which has put in at Dunkirk to revictual, left Pampeluna on New Year's-eve with a cargo of Orsini bombs, destined for St. Petersburg. Stress of weather obliged her to take refuge at Bordeaux, and on her continuing the voyage, several of the bombs exploded, killing three of the crew. After a month's detention at Havre, the authorities allowed her to proceed, being satisfied that there was no further danger, but on reaching Dunkirk, the captain learned what had happened at St. Petersburg, whereupon he reported to the Russian Consul the nature of his cargo, and has suspended his voyage pending an investigation."—*Times*, March 21, 1881.

Mar. 21 ...Attempt to blow up the Egyptian-hall of Mansion House, London, with gunpowder.

Infernal machines have long been used in warfare; being first introduced by an Italian engineer, and used at siege of Antwerp, 1584-5.

CONCLUDING OBSERVATIONS.

The subject—which, I believe, has not been previously treated of as a whole—has grown upon my hands. This paper can still only be regarded as a nucleus for further inquiry and observation. The Employers' Liability Act, 1880, will force the consideration of the great risks arising from boiler explosions more fully upon employers than heretofore. And, in truth, there need be small pity for those who shall be found defaulters in this regard. The means of safety are ready at hand. The insurance companies have their agencies in all parts of the kingdom. A proposal to insure, in fact, secures inspection, and hence almost certain discovery of defects. Insurance here, as in many other cases, affords nearly all the remedy needed. I take it, that no insurance association, guaranteeing an employer under the provisions of the Act, would think of entering upon a risk where the employer had not insured his boiler. That should be, *prima facie*, an act of negligence.

I have made an effort to estimate the annual loss of property resulting from explosions of various kinds in this country; but the data available is altogether insufficient for the purpose. The loss of life is very sad, but can be approximated through the aid of the returns with which I have already dealt. I do not believe those returns to be yet complete.

It is in connexion with colliery explosions, perhaps, that the greatest loss is sustained. In 1865, there were as many as 3,268 collieries in the United Kingdom, employing 307,542 miners, who produced 98,150,587 tons of coal, valued at the pit's mouth at £24,537,646. In 1873, the number of collieries had increased to 3,527, and all the other figures in a like degree. There is now a much larger number at work. In one of the most dangerous districts of the kingdom, there had occurred, in 16 years, accidents by explosion, costing £56,914; these ranged from £200 to £25,000 each. This—supposing all collieries to be equally fiery, which is happily not the case—would give £910,624 as the loss sustained throughout the United Kingdom in 16 years, being £28,457 per annum. The total value of 3,180 collieries at another period was estimated at £70,000,000, giving an average of £22,000 per colliery; hence, the rate of premium to be paid for insurance against colliery explosions might be nearly calculated; but there are other difficulties in the way. Besides, we are not here to discuss insurance, except in so far as it may aid in the reduction of the number of accidents. In some Continential countries, as, for instance, Austria, insurance against explosions of all kinds is very general. I think it may, with advantage, be made so here.

In furnishing the details herein contained, my object has been the prevention, *i.e.*, the lessening the number of explosions of all kinds. The details of the occurrences and their causes are designed as a means to this end. To know the cause of an evil is sometimes regarded as half the remedy. I sincerely trust it may prove so in this instance. Science may, in this matter, help forward the cause of humanity. I look to those now present, or who may read this paper in the *Journal* of the Society, to do their share in the following up the considerations I have raised, and in throwing light upon points which I may have overlooked.

NOTE.—I have not attempted on this occasion to deal with those great convulsions of nature—physical explosions—usually designated earthquakes. I am treating of these in connection with my inquiry into plagues and pestilences. It will be observed that I have almost in every instance, given the month and day of the explosions here recorded. This is done very much in view of meteorological investigation hereafter.

DISCUSSION.

Mr. Christopher Cooke said he remembered an explosion at a firework manufactory, in the Westminster-bridge-road, by which several lives were lost. Explosions of gas he thought were generally due to ignorance and carelessness, through people going to look for an escape of gas with a lighted candle. He believed the researches of Scott and Galloway showed that there was a connection between the atmospheric pressure and explosions in coal mines.

Mr. Longridge said he was only specially interested in one out of the many cases of explosions which had been treated of, viz., boilers, and he had come rather to listen than to speak, hoping to get some further statistics on the subject, as he knew that Mr. Walford had a great faculty for obtaining and utilising information of that character. He had been more occupied with the inspection of boilers than inquiring into the causes of explosion, but he quite agreed with Mr. Walford that most of these explosions could be prevented by efficient inspection. He

was, however, opposed to compulsory inspection, because it would be a great obstacle to progress. They saw what had been done in the way of compulsory inspection of factories, mines, and steamers, and he did not think the results were sufficiently encouraging to warrant extending the system. The inspection of steam-boilers was being carried out at present by the insurance companies, and he thought compulsion would be a mistake. It would necessitate the setting up of a standard, to which every boiler must conform or be condemned, whilst it would be impossible to fix any standard which would be applicable to all boilers, working as they did under so many different conditions. Again, if you had compulsory inspection, you relieved the boiler owner from an immense amount of responsibility; he would be compelled to adopt the recommendations of the inspector, and would then claim to be relieved of that responsibility which every boiler owner ought to be under. The course proposed in Mr. Mason's Bill was far preferable; and he must say, from some experience, that the inquiries as at present conducted were almost ludicrous. The absurd questions put by the coroner, or by the lawyers, led to an immense waste of time; whereas, if there were a couple of men who understood the subject, the inquiry would be got through much quicker, and a more satisfactory result would be arrived at. Under the present system the almost invariable result was a verdict of accidental death, though in one or two cases there had been a verdict of manslaughter. In one case in Scotland, where a man was tried for manslaughter, the jury returned a verdict of "not proven." If they could get the causes determined, explosions might be prevented in future. They were generally said to be accidents, but in the majority of cases that was simply untrue.

Mr. Pfoundes said he had seen a little of the use of steam in the colonies and the East, both afloat and ashore, and on one occasion witnessed an explosion by which more persons were hurled into eternity than he saw at present before him, and many more were seriously injured. At that time he was organising a large steam-ship company on the coast of China and Japan, and, from his experience of what were commonly called the black squad, he only wondered there were not more accidents than there were. They were, he believed, in many cases, due to the gross carelessness, and even incompetence, of the men in charge of the boilers. He could not speak of the effect of steam hammers on boilers, but he could say, from personal experience, that boilers used in connection with stampers for crushing quartz, and brought close to the stampers, as they often were to avoid loss of steam, were seriously affected by the constant vibration. He would urge the necessity of encouraging a more intelligent class of young men to come forward, and make themselves competent to take charge of steam-boilers; and he did not think a little higher rate of pay would be a very heavy tax on the owners of steam machinery. In Yokohama and Jeddo he had seen many hundreds of men who applied for situations; but really steady, competent, sober men were in a lamentable minority.

Mr. F. J. Bramwell, F.R.S., said this most interesting paper touched on so many subjects that it was impossible to discuss it as a whole, but there were one or two matters alluded to which had come within his cognisance, and on which he might say a word or two. He had had a good deal to do with flour mills, and with the introduction of the blast and exhaust into English mills, which the late Mr. Rankine seemed to think responsible for the explosions from flour dust. Now he observed that both the great explosions in America and in Glasgow occurred when they were grinding, not wheat, but what was called in America and in England, middlings, and in Glasgow was called sharps. That meant regrinding a portion of the meal which had been taken out in the operation of dressing, and had to be further ground and re-dressed. The material arising from this re-grinding would be much drier than if it were the product of the wheat itself; indeed, in the United Kingdom especially, when grinding home-grown wheat, the difficulty was, not to prevent the exhaust trunks from being too dry, but, on account of the evolution of moisture, to prevent their contents fermenting and becoming offensive. In the United States there was a greater chance of the conditions favourable to an explosion occurring, both because the wheat was drier, and because it was the habit, when he was there some years ago, to run the mills at a much greater rate than English millers could afford (afford because this rate was accompanied by a bad yield), and the heat thus generated would be much higher than when the grinding was carried on more slowly. It would be easily understood how, when there were circumstances favouring the production of dry dust, which was diffused through the atmosphere, it was very possible for an explosion to occur. The great cause of gas explosions was, no doubt, that people would go, as had been said, to look for an escape with a lighted candle, which they generally held high over their heads; but after all, he did not think gas had been an additional source of danger. It was true that tallow candles and whale oil did not explode, but many more accidents occurred from sparks falling from an unsnuffed candle, from candles falling out of candlesticks, from lamps upsetting, and things of that kind, than arose from gas, the flame of which was generally put in a position where it could do no harm. With respect to explosions of gas works themselves, there had been some few cases, but very few; and he did not agree that the presence of gas works in centres of population was a source of danger. It would be found that the explosion of gas-holders had not occurred when they were in use, but when they were under repair, imperfectly emptied, and the air was suffered to enter them, and thus an explosive mixture was formed. He remembered one instance at Preston, where a gas-holder which was under repair had not been properly emptied, and a red-hot rivet being thrown in, the mixture exploded. He did not see that there was the slightest chance of an explosion while the manufacture was going on and the gas-holder was full. At the Goswell-street station of the Chartered Company, some 15 years ago, a girder fell upon the gas-holder and broke it, and a neighbouring flame set fire to the gas, and the whole gas in the holder burned right out without an explosion; it was simply an enormous gas bonfire. He was glad to find there was a steady decrease in the number of boiler explosions, which was doubly encouraging, as the number in use must be largely on the increase. Reference had been made to the frequency of explosions in iron works, and it was suggested that this might arise from the boilers being jarred by the action of the machinery. He very much doubted if that were so, and such a cause was not needed to account for the frequency of explosions in these works, as there were other reasons which, in his judgment, were quite sufficient. In iron works very often the waste heat from as many as four furnaces was directed against the outer shells of boilers of very large diameter, a construction adopted when the usual pressure of steam was about 5 or 6 lbs. to the inch, a construction that had been continued when the pressure had risen to 40 or 50 lbs. The furnaces were often, from various causes, not all working at the same time, so that sometimes one portion of the boiler was heated, and sometimes another, and thus it was exposed to a succession of injurious strains which did not occur under ordinary circumstances of boiler use. If the plates were not of the most ductile description, these strains gradually produced cracks, and the boiler leaked; then it was calked, and the very act of calking tended to its destruction, and, finally, it exploded. Then,

being situated in the centre of three or four furnaces, at each of which two men worked, and, generally speaking, close to other boilers and furnaces of similar construction, the result was generally very destructive; bricks were hurled in all directions, and much damage ensued. Of late years, however, the matter had been much better understood; and now it was usual for the heat from one furnace only to operate on the boiler, and the boiler, instead of being surrounded by brickwork, was placed overhead, and covered with a non-conducting material; the heat drew through one or two internal flues only; it was fairly treated as regards expansion and contraction; it was in full view for inspection, and even if an explosion did occur, it was not likely to do so much damage. It had been proposed, as a preventive of explosion, that the use of waste heat from the furnaces should be abandoned, but having regard to the frightful competition there was by Belgian manufacturers, which resulted in a great many of the wrought-iron joists used in building being now imported, instead of being made in England, it would be impossible for English manufacturers to hold their ground at all, if the great economy arising from the utilisation of this waste heat were thrown away. He must dissent from the approval which had been given to the Board of Trade regulations with regard to steamboats, which he believed had done a great deal of harm. We were rapidly getting into the condition which Mr. Longridge had pointed out would be the result of the introduction of compulsory inspection generally. If the Board of Trade regulations with regard to marine boilers were applied to locomotives, the result in round figures would be this, that the pressure used in locomotive boilers, which very rarely exploded, would have to be reduced one-half, and the result would be an enormous increase in the consumption of coal. He would here repeat what he said to the Boiler Explosion Committee in 1871, when an attempt was made to introduce legislation which would have been destructive to mechanical improvement in this country. He then referred to statistics which had been quoted to-night. In a paper read at the meeting of the Institution of Mechanical Engineers at Nottingham in 1870, it was stated that there were 55 explosions per annum, causing 80 deaths, of which, on the average, $13\frac{1}{2}$ arose from the negligence of the attendant—which no inspection would have prevented—and $3\frac{1}{2}$ from kitchen boilers. Thus there were 17 out of the 55 which inspection could not prevent, leaving 38 which might have been prevented by the most perfect inspection. It also appeared that when inspection took place, one boiler in 4,600 exploded (now, it appeared the proportion was one in 16,000) as against one in 2,000 without inspection, so that the inspection only saved 55 per cent. It therefore came to this, that inspection as then practised would only have saved 46 lives out of 80. Taking the number of boilers, as nearly as could be ascertained, at 110,000, excluding railways, and making the best average possible of the consumption per horse-power, it appeared that if anything were done which would increase the consumption (or would prevent a saving) of 1lb. of coal per indicated horse-power per hour, it would involve the consumption of four million tons of coal in a year. Now, looking at the returns of the inspectors of mines, taking one year with another, it appeared there were ten violent deaths for every million tons of coal raised. If, therefore, a measure were passed which would have the effect of stopping the improvement of boilers, and lead to a want of economy of 1 lb. of coal per horse-power per hour, you might save 46 lives by boilers not exploding; but you would not only be wasting coal, but would be wasting 40 lives in extracting it. As he pointed out to the committee, you might buy anything too dear, even human life, especially when you bought it with other human life. He was glad to find Mr. Walford came to the conclusion that obligatory inspection was not desirable, and Mr. Longridge had very forcibly pointed out some objections to it. However unnecessary the orders of the inspector, the owner would be practically compelled to obey them, and having done so, he would cease to be responsible. He might give an instance of how this would work. Many present were acquainted with the system of heating by hot water carried out by Mr. Perkins. Many years ago Mr. Perkins's father employed that mode for heating boilers; he applied the fire to hot-water pipes, which circulated within the boiler, and the boiler itself never saw the fire at all. A boiler thus constructed had been working 28 or 38 years (he forgot which) at the warehouse of a well-known furniture manufacturer in Tottenham-court-road. He had his boiler inspected by some boiler insurance company, and the order was given that the boiler ought to be discontinued, because it was so many years old. The question was put, "What is the matter with it?" and they could not find anything the matter with it, but still, it was so many years old. The owner felt compelled to have it replaced by a new one. He applied to Mr. Perkins for a new one of the same kind, when Mr. Perkins said there was no need to replace it, as there was nothing the matter with it; and, at any rate, before it was taken out, he should like to see if he could burst it. Accordingly, he (Mr. Bramwell) and several others went to see this boiler burst. It ordinarily worked at a pressure of about 50 lbs., and the pressure was got up to 200 lbs., when it leaked so much at all the seams, that it was impossible to get the pressure any higher. Yet this boiler had to be replaced on account of its age, when it was being safely worked at a pressure of one-fourth of that at which it leaked like a sieve, so that it would have been impossible to explode it. Another point which he brought before the committee, in connection with the economy of fuel, was this. In non-condensing engines especially, it was usual to turn the waste steam into the feed water so as to heat it, and thereby economise fuel, and this was very commonly done by simply blowing the waste steam into the water. This was forbidden by the engineer to a boiler insurance company, who said that it was liable to introduce grease into the water, and that this would act injuriously on the boiler. He pointed out to the committee of 1871 that if there were compulsory inspection, the great object of an inspector would be to say that there were no explosions in his district, and he would give orders which would ensure that result. Now the great bulk of the small engines in use throughout the country were of a very wasteful kind, being non-condensing engines, working at a comparatively low pressure, usually about 30 lbs. to 35 lbs. pressure above the atmosphere, a pressure which, being reduced by the throttle valve, would not show more than about 14 lbs. in the cylinder. Now the inspector going into a factory where 35 lbs. of steam was being used, would be very likely to say, I will allow you to use the boiler, if you reduce the pressure 10 lbs., which the owner would probably agree to, rather than go to the expense of a new boiler, and the result would be the consumption of so many tons extra of coal per year. He had been very much pleased with the lucid statement of Mr. Longridge, whose prejudices certainly, if he had any, must have been in favour of inspection. No doubt it was very undesirable that anybody should be killed by avoidable accidents; and when explosions did occur, they were very startling and horrible; but before doing anything which would interfere with the progress of engineering improvement, on which the prosperity of the country depended, it would be well to stop the unnecessary loss of life in other directions. At the present time, the deaths from street accidents in London alone were from five to seven a week, or three or four times the number which were caused by boiler explosions throughout the whole country, and he thought attention should be given to such matters as these before anything was done which would interfere with mechanical improvements or with economy in fuel.

Mr. Gosling suggested that if a system of insuring

domestic boilers were instituted, many persons would take advantage of it, for many persons to whom he had spoken on the subject had expressed their desire to have their boilers inspected. He found that in many cases they had been in use for many years without being inspected. He often found, especially in country boilers, that the persons in charge of steam-boilers were lamentably ignorant and incompetent. One of the most important things to be looked to was to get a better class of men to attend to boilers.

The Chairman said there was so much matter in the paper that it was very difficult to deal with it except in the way of general approval, and some points on which he should have liked to touch, he hardly felt free to deal with. The question of accidents in mines was now in the hands of a Royal Commission, of which he was a member, which was carefully investigating the subject, and he hoped some fruitful results might ensue. He might point out, however, that the accidents in coal mines due to explosions, formidable as they were, bore but a small proportion to the accidents due to other causes, by which one or two lives only at a time were sacrificed. It would be a mistake to introduce anything like over-legislation in connection with any branch of the subject; and it should be borne in mind, as Mr. Bramwell had justly observed, that there were other important sources of casualties which equally required to be dealt with. Many accidents ascribed to explosions were not due to explosions at all, especially those in connection with petroleum. As had been said, explosions did occasionally occur in manufactories or stores of petroleum, but the accidents with petroleum were generally due to spilling, or overturning of lamps, not to an explosion in the lamps themselves. Again, in the case of chemical explosions, which embraced a large variety of accidents, many would hardly come properly under the description frequently given of them. In some instances they might be due to spontaneous action occurring amongst substances mingled or brought together, or they might be due to the secondary action of fire, which caused an explosion. In the case of the Gateshead explosion, although it was chiefly attributed to the action of steam, there were all the elements of a gigantic explosion of gunpowder present. There was an enormous store of nitrate of soda, which was only another name for saltpetre, besides large stores of sulphur, and of charcoal or carbonaceous matter, and although the explosion might be due to large volumes of water meeting with highly heated matter, yet those materials meeting in a highly heated state might develop suddenly large volumes of gas under high pressure, and thus contribute to the violent explosive effects produced. With regard to explosions due to dust, on which Mr. Bramwell had given interesting information, he had lately had occasion to look into this subject, and regretted that time and other circumstances did not admit of his giving the results of numerous experiments he had made in connection with the influence of dust on explosions in coal mines; but there was no doubt it was much greater than they had been disposed at one time to believe; and that serious and fearful as was the effect of fire-damp, in many instances coal-dust itself played a part quite as serious, if not more so. He concluded by proposing a vote of thanks to Mr. Walford.

The vote of thanks having been carried unanimously,

Mr. Walford briefly acknowledged the compliment, and said he trusted that the subject would, from time to time, receive that attention and elucidation which it deserved on the score of humanity. He thought there was a real reason why marine boilers should be placed under more stringent regulations than land boilers: as a ship at sea, in the event of a boiler explosion, presented a case of real disaster.

MISCELLANEOUS.

SANITATION AT THE GOVERNMENT OFFICES.

Mr. Gorst asked in the House of Commons, on Monday, 21st inst., for information respecting the sanitary alterations about to be made in the public offices. In reply

Lord F. Cavendish said that nothing was so difficult as to say how much works of this nature would cost. The War-office was in a satisfactory condition, but it was almost the only public office that was so.

Sir R. Cross said that he had found when he was at the Home-office that he suffered much from severe headaches. The clerks refused to go to the new offices on account of their unsatisfactory condition, and he himself had almost resolved to take lodgings in the neighbourhood and charge the Treasury with the cost. They could find no plan of the drains, and ten holes were made in Whitehall-place before the junction with the main drains could be found, and then there was discovered 2 ft. of sewage matter. It was a matter that must be thoroughly investigated, and remedied at all hazards and all costs. Unfortunately, it was impossible to say what the cost would be.

Lord John Manners said that it was absolutely necessary that these sanitary improvements should be carried out without delay. When the new great public buildings were undertaken, the highest engineering skill should be employed to insure that the sanitary arrangements were properly carried out.

Lord F. Cavendish said that, with the exception of the War-office, nearly all the public offices, like too many of the other houses in the neighbourhood of Whitehall, were in an unsatisfactory condition. They, therefore, proposed a substantial vote, and intended to begin with the worst of those offices, the Home-office. The whole system of drainage was bad, but the fault did uot lie with the architects. He might mention that the Board of Works had laid down certain simple regulations to prevent the recurrence of the evil.

COPYRIGHT.

The Committee of the Jurisprudence Department of the Social Science Association have been engaged in the preparation of a series of twenty-one heads, in which they deal with the whole question of copyright. The following is an abstract of the heads which it is proposed to incorporate in a Bill hereafter to be brought before Parliament:—

1. That registration of copyright in works of all classes published in the United Kingdom, and in dramatic or musical works first performed in the United Kingdom though not published (but not in paintings, drawings, or sculpture, since there is nothing in them analagous to publication), should be compulsory.

2. That if owners of copyrights in paintings, drawings, or sculpture, should desire to register their copyrights, for the purpose of evidencing their title or otherwise, they should have power to do so.

3. That it is desirable that registration should be effected at a Government office, to be established and maintained for that purpose.

4. That in the case of books, photographs, engravings, prints, or similar works, copyright should mean the exclusive right of multiplying copies of the work protected.

5. That the term of copyright should be fifty years from the date of registration.

6. That in the case of paintings, drawings, or sculpture, copyright should mean the exclusive right of multiplying copies of the design of the work protected.

7. That in the case of paintings, drawings, or sculp-

ture, the term of copyright should be the life of the artist and thirty years after his death.

8. That on the sale of a painting, drawing, or piece of sculpture, or when such work is executed on commission, the copyright in it should remain with the artist in the absence of a written agreement to the contrary. That the purchaser or other owner of a painting or drawing should be protected against replicas.

9. That the present law by which, in the case of articles in magazines, reviews, or other collective works except encyclopœdias, written and paid for on the terms that the copyright shall belong to the proprietor of the collective work, a right of separate publication reverts to the author after twenty-eight years, should be modified, three years being substituted for twenty-eight.

10. That the present law as to presentation of books to the British Museum and other libraries should remain unaltered.

11. That in the case of British subjects copyright under this Act to be passed should extend to all the British dominions.

12. That aliens, wherever resident, should be entitled to copyright in paintings, drawings, and sculpture, if they bring their works into the British dominions in order to retain or sell them there; and to copyright in works of all other classes.

13. That a British author, who first publishes his work out of the British dominions, or whose play or musical composition is first performed out of those dominions, should not be prevented thereby from obtaining copyright in those dominions by subsequent publication or performance therein.

Headings 14, 15, relate to the power of search which it is proposed to confer; 16, 17, to the colonial question, and 18, 19, 20, 21, to copyright in foreign books and plays.

The subject of artistic copyright is one in which the Society of Arts has long been interested. In 1858, a committee was appointed by the Society, with the late Sir Charles Eastlake, President of the Royal Academy, as chairman, to consider the subject, and the ultimate result of their labours was "an Act for amending the law relating to Copyright in works of the Fine Arts, and for repressing fraud in the production and sale of such works," which was passed in 1862.

An abstract of Lord John Manners' Copyright Bill, 1879, is printed in the *Journal*, vol. 27, p. 879.

NOTES ON BOOKS.

Horticultural Buildings: their construction, heating, interior fittings, &c., with remarks on some of the principles involved, and their application. By F. A. Fawkes. London: B. T. Batsford.

The author points out that while much is written upon plants, flowers, and fruits, it is somewhat difficult to obtain information respecting the proper construction and arrangements of buildings required for the cultivation of those plants, flowers, and fruits. He, therefore, set himself to produce a volume in which an architect could find just those constructional and mechanical points which are required by the horticulturist, and in which a gardener could find details beyond his province with which he should be acquainted. The various questions relating to growing-houses, show-houses, garden-frames, subsidiary buildings, and the materials used in them, besides the apparatus used for heating, ventilation, and water supply are all dealt with in this volume, which contains numerous illustrations.

The Fields of Great Britain: a Text-Book of Agriculture, adapted to the syllabus of the Science and Art Department, South Kensington. By Hugh Clements, with an introduction by H. Kains-Jackson. London: Crosby Lockwood & Co., 1881.

This little book is a reprint of a series of articles contributed to the *Farmer*, and is intended by the author to form a text-book for the use of teachers and students of agricultural classes connected with the Science and Art Department, the elementary and advanced stages being dealt with as a whole. The chief subjects treated of in the different chapters are, soils, irrigation and drainage, farm buildings and implements, crops, constituents of food, stock, &c.

Andrea Sansovino und seine Schule. Für Künstler und Kunstfreunde, von Dr. Paul Schönfeld. Stuttgart: verlag der J. B. Metzler'schen Buchhandlung, 1881.

Dr. Schönfeld has here given a study of the works of Andrea Sansovino, the great sculptor and architect of the Italian Renaissance, and of those of the school which he formed around him, including Jacopo Sansovino, Alfonso Lombardo, Niccolo de' Pericoli, Francesco da Sangallo, Lionardo del Tasso, and other famous sculptors. In illustration of the essay there are added thirty permanent photographic plates of the chief works of these artists.

GENERAL NOTES.

Gas-lighted Buoys.—Compressed gas for the illumination of buoys, according to the *Times*, is gradually coming into use. Ordinary coal-gas is not employed, but an oil-gas, manufactured upon Pintsch's system, which has been adopted by several railway companies for carriage lighting. The gas is produced by distilling the refuse of shale oil, the gaseous products being stored and used under pressure. The buoy is made of wrought iron, and is itself the receiver of the compressed gas for use. A lamp is mounted on the top, which will burn for six, nine, or twelve weeks with one filling, according to the capacity of the buoy. The Trinity House has had two of these buoys under trial, their performances having been reported on as satisfactory. One of these buoys was placed on the East Oaze station, about one and three-quarter miles from the Mouse lightship, on the 18th of last April, and remained at its station until the 28th of January, when it was run into and damaged by a passing vessel. The Trinity House officials report that, during the period named, the light was burning without intermission, although it is stated by the officer in charge of the Mouse light-vessel that, in bad weather, the buoy was at times hidden from view by the spray. The Clyde Lighthouse Trustees have also taken the matter up, and are building gasworks at Port Glasgow, on Pintsch's system, for the service of gas-lighted buoys on the Clyde. One of these buoys has been burning on the Roseneath Patch for some time past, being supplied with gas from London, and a second is about to be delivered by Pintsch's Lighting Company for use on the Clyde. Another of these buoys is about to be despatched by the company to Port Said for use on the Suez Canal. It is seven feet in diameter, and will contain a sufficient supply of gas under pressure to give a light day and night for six weeks. The light burnt will be a red one, and the gas will be stored at a pressure of seven atmospheres, or 105 lbs. per square inch. The estimated cost of the gas is only 2½d. for twenty-four hours' consumption. The process of filling these buoys can be carried out in a few minutes. The reservoir of gas under pressure is floated alongside them in a tender, and the gas is passed from the reservoir into the buoy by means of a flexible tube.

Beaumont Compressed Air-Engine. — It should have been stated that the blocks of the illustrations of the "Beaumont Compressed Air-Engine," and the "Experimental Engine," in the last number of the *Journal* (p. 386), were kindly lent by the proprietors of the *Graphic* newspaper.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

March 30.—"Recent Advances in Electric Lighting." By W. H. Preece., M.Inst.C.E. C. W. Siemens, LL.D., F.R.S., will preside.

April 6.—"The Discrimination and Artistic Use of Precious Stones." By Professor A. H. Church, F.C.S. Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E., will preside.

April 27.—"Five Years' Experience of the Working of the Trade Marks' Registration Acts." By Edmund Johnson.

May 4.—"Buying and Selling; its Nature and its Tools." By Professor Bonamy Price, M.A. Lord Alfred S. Churchill will preside.

Dates not yet fixed:—

"The Manufacture of Glass for Decorative Purposes." By H. J. Powell (Whitefriars Glass Works).

"The Electrical Railway, and the Transmission of Power by Electricity." By Alexander Siemens.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

April 5.—"Canada; the Old Colony and the New Dominion." By E. Hepple Hall. John Rae, M.D., F.R.S., will preside.

May 10.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

May 12.—"Recent Progress in the Manufacture and Applications of Steel." By Professor A. K. Huntington.

May 26.—"Telegraphic Photography." By Shelford Bidwell. Prof. W. G. Adams, F.R.S., will preside.

Indian Section.

Friday evenings, at eight o'clock:—

March 25.—"The Tenure and Cultivation of Land in India." By Sir George Campbell, K.C.S.I., M.P. Andrew Cassels, Member of Council, will preside.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Third Course is on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Four Lectures.

Lecture IV.—March 28.

Subdivisions of the electric current. Incandescent lamps. Luminous effects of electric currents in a vacuum, and in various gases.

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Four Lectures.

Syllabus of the Course.

Lecture I.—April 4.

Introduction. Early forms of twisted, plaited, and looped threads. Ornamental borders of Assyrian, Greek, Roman, and other costumes. Sumptuary laws. Venetian books of patterns for embroidery and lace. Flanders a centre of linen trade of Europe. Spanish and French importations of early lace. Effect of production of machine-made lace upon production of hand-made lace.

Lecture II.—April 11.

Needlework upon a material. Needlework upon separate threads. Venetian needle-point lace. Needle-point and tape lace. French needle-point lace-making centres. English and Flemish needle-point lace.

Lecture III.—May 2.

Fringes. Twisted thread-work in England in the 15th century. Early designs for plaited and twisted threads. Italian, Flemish, French, and English pillow lace. Laces of primitive design.

Lecture IV.—May 9.

Resumé as to styles of design in hand-made lace. Traditional patterns. Sketch of the development of inventions for knitting and weaving threads to imitate lace. Differences between machines and hand-made laces. Modern hand-made laces at Burano, Bruges, Honiton, &c.

This course will be illustrated by specimens of lace. Diagrams and photographs enlarged will be shown by means of the lantern and oxyhydrogen light.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures. May 16, 23, 30.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 28th...**SOCIETY OF ARTS,** John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor W. G. Adams, "The Scientific Principles Involved in Electric Lighting." (Lecture IV.)
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. J. B. Minchin, "Eastern Bolivia and the Gran Chaco."
British Architects, 9, Conduit-street, W., 8 p.m. Mr. J. J. Stevenson, "Historical Documents."
Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. Cornelius Walford, "The Position of the Insurance Press in Relation to Insurance Offices and Insurance Interests."
Medical, 11, Chandos-street, W., 8½ p.m.

Tuesday, March 29th....Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. A. Schäfer, "The Blood." (Lecture XI.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. David Phillips's Paper "The Comparative Endurance of Iron and Mild Steel when exposed to Corrosive Influences."
Royal Colonial, Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Discussion on Mr. Torrens's Paper on "Imperial and Colonial Partnership in Emigration," will be resumed.

Wednesday, March 30th...**SOCIETY OF ARTS,** John-street, Adelphi, W.C., 8 p.m. Mr. W. H. Preece, "Recent Advances in Electric Lighting."
Royal Botanic, Inner-circle, Regent's-park, N.W., 2 p.m. Exhibition of Spring Flowers.
Chemical, Burlington-house, W., 8 p.m. Annual Meeting.
Royal College of Physicians, Pall-mall East, 5 p.m. (Croonian Lectures.) Dr. Moxon, "Influence of the Circulation upon the Nervous System." (Lecture III.)

Thursday, March 31st...Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. H. Statham, "Ornament Historically and Critically Considered." (Lecture III.)
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. G. J. Child, "Lifts for Warehouses, &c."

Friday, April 1st...Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lectures.) Dr. Southey, "Bright's Disease." (Lecture I.)
Royal United Service Institution, Whitehall-yard, 3 p.m. Captain Walter H. James, "On the Best Means of Adapting the Existing Military Forces to the Requirements of the Empire."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m., Sir Henry S. Maine, "The King, in his Relation to Early Civil Justice."
Geologists' Association, University College, W.C., 8 p.m.

Saturday, April 2nd ... Ladies' Sanitary Association (at the House of the Society of Arts), 5½ p.m. Dr. B. W. Richardson, "Domestic Sanitation or Health at Home." (Lecture VII.)
Royal Institution, Albemarle-street, W., 3 p.m. Rev. H. R. Haweis, "American Humorists." (Lecture III.)

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, APRIL 1, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The fourth and concluding lecture of the third course was delivered on Monday, 28th of March, by Professor W. G. Adams, F.R.S., on "The Scientific Principles involved in Electric Lighting." The special subjects treated of in this lecture were the subdivisions of the electric current, incandescent lamps, &c. The Joel, Werdermann, and Swan lamps, which were lent by the inventors, were exhibited in action. The Swan lamps were supplied by a Bürgin machine, lent by Mr. Crompton. A Gramme machine was also lent by the British Electric Company. The motive power, as at the last lecture, was provided by a Robey engine.

A vote of thanks to the lecturer was proposed by the Chairman (Mr. F. J. Bramwell, F.R.S.), and carried unanimously.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1881, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., F.R.S., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially, by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (afterwards Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., "in recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, For. Memb. R.S., Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. (now Sir) Henry Bessemer, F.R.S., "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to Michel Eugène Chevreul, For. Memb. R.S., "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvement in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Michel Chevalier, "the distinguished French statesman, who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

In 1876, to Sir George B. Airy, K.C.B., F.R.S., Astronomer Royal, "for eminent services rendered to Commerce by his researches in nautical astronomy, and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships."

In 1877, to Jean Baptiste Dumas, For. Memb. R.S., member of the Institute of France, "the distinguished chemist, whose researches have exercised a very material influence on the advancement of the Industrial Arts."

In 1878, to Sir Wm. G. Armstrong, C.B., D.C.L., F.R.S., "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power—hydraulically—due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided, and mechanical power beneficially substituted for most laborious and injurious manual labour."

In 1879, to Sir William Thomson, LL.D., D.C.L., F.R.S., "on account of the signal services rendered to Arts, Manufactures, and Commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables."

In 1880, to James Prescott Joule, LL.D., D.C.L., "for having established, after most laborious research, the true relation between heat, electricity, and mechanical work, thus affording to the engineer a sure guide in the application of science and industrial pursuits."

The Council invite members of the Society to forward to the Secretary, on or before the 23rd of April, the names of such men of high distinction as they may think worthy of this honour.

LABEL FOR PLANTS.

The Council are prepared to award a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary not later than the 1st May, 1881.

The Council reserve to themselves the right of withholding the Medal and Prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Friday, March 25, 1881; Andrew Cassels, Member of the Council, in the chair.

The paper read was on—

THE TENURE AND CULTIVATION OF LAND IN INDIA.

By Sir George Campbell, K.C.S.I, M.P.

My subject being "The Tenure and Cultivation of Land in India," I shall first speak of the tenure of the land. The most prominent feature throughout India is this, that everywhere the soil is held by small farmers not above the position of labourers. Speaking generally, it may be said that there are no large farmers. We found that in India under the native system the rent was in the main retained for the purposes of Government. The Government dealt with villages; those villages were little Republics—the units of the State; they managed their own affairs, distributed the revenue demand, and provided for many common expenses and common necessities by a well-arranged system of local rating. Under our system, the revenue demand has been moderated, but much variety of tenure has been introduced intermediate between the Government and the people, giving rise to very various forms of property. It seems to me that in this process we have done harm, from acting upon English ideas, in two directions. In some parts of India we have attempted to establish landlords, in the hope that they will perform the functions of English and Scotch landlords; in reality they have entirely failed to do so, and the people are under this system more rack-rented than under the native Governments. The free-trade system of free contracts between landlord and tenant has answered no better in India than in Ireland; in some cases great political difficulties have resulted, as when through mere ignorance we have imposed Bengalee and other landlords over Sontals, Gardos, and other aboriginal tribes, the autochthenes of the soil, and, in their view, its true owners. In other parts of the country, an opposite course has led to another class of difficulties; there, rejecting the landlord system, we have made the ryots, the cultivators of the soil, absolute owners of the soil, and insisting upon the advantage of individual property, we have put an end to the system under which, in a village community, the combined cultivators had the strength attributed to a bundle of sticks. This course was certainly taken with the best intentions in the world, but it has turned out that in some cases an unaccustomed form of property, given without price, and without safeguards and limitations, to people who did not understand it, has been treated by them as children treat a gift beyond their years; they have made too much use of their new-found credit, they have become involved with money-lenders, and signed away their rights. They have been sold up by the Courts under our rigid system of law, and sometimes, as in the case of the Deccan ryots, their last state has become worse than their first.

Fortunately the landlord system has been carried out to the fullest extent, only in Oude, where nine-tenths of the cultivators are mere rack-rented tenants at will, without any rights at all, and where great agrarian and social difficulties have resulted. In the Bengal provinces, by the laws of the permanent settlement the ryots were protected, and had fixity of tenure in the same way as the zemindars had; and to this day the Bengal ryots sturdily maintain much of their rights; but in the great province of Bahar, recent inquiry has shown, that owing to a combination of circumstances, and of superiors, the Bahar ryots have been wholly deprived of their rights and reduced to a very miserable position. In the North-West Provinces, the Central Provinces, and other parts of India, more or less protection is given to the ryots. I believe that is so in Madras also; and I hope Sir Willian Robinson will give us some information in regard to the position of those cultivators in Madras, who hold under superior proprietors.

The difficulty in regard to the ryots' property, in land so imprudently dealt with, has been felt more in the Bombay Presidency than in any other part of India, and is in some degree owing to peculiar circumstances; the excessive variation in the price of cotton, the too sudden extension of cultivation under new settlements, and the sudden rise of revenue when a revision takes place. In some districts of Eastern Bengal, where the tenure is practically ryotwar, the people seem to get on very well, although the titles are now very complicated; and in the Punjaub, where individual property is combined with the village system, I hope that the people are really prosperous and contented, in spite, too, of difficulties made apparent during the recent famine. I trust gentlemen who know Madras and Bombay better than I do will be able to tell us that, in parts of those presidencies also, the cultivating ryots are pretty prosperous.

The moral, however, of the difficulties which

have been experienced, both under the landlord system and under the ryotwar system, seems to me to be that it was a mistake too suddenly to introduce our ideas of property, and that a limited sort of property of the nature of a liberal fixity of tenure is more suited, at any rate in the first two or three generations, to our rule in India.

As regards the size of farms, we cannot expect that we shall get rid of the poor and small peasant farmers; nor would I, for one, at all desire to do so. It has always seemed to me that, whether he work harder or no, and perhaps the harder he works the better, the small peasant farmer is a more responsible, prudent, managing man, than a mere labourer, and a better member of society, even in cases where the labourer earns more money. There is no prospect of the general introduction of any system of large farming; though I do not desire that, I much feel that in all countries variety is good, and that large, rich, and progressive farmers are very useful indeed as an example to others. Though I have no belief in the landlord system in India, I think it is very desirable, that for the purposes of large farming, some land should be available for those who desire to undertake it. In Bengal, there is an immense variety of tenure and land that might, no doubt, be made available for money, if it were not for the immense complication of titles; in this respect simplification of titles is the great need of Bengal. It was the practice to give tea planters land, in fee simple, at a moderate price. and in the case of land which had hitherto lain wholly waste. I have been by no means adverse to the system, so long as land-jobbing was avoided; but there was at one time a great tendency to land jobbing, an abuse which it was very necessary to check.

I may say that in India we have nowhere the three-fold function of capitalist-landholder, capitalist-farmer, and labourer, but we have in some parts a three-fold set of functions, namely, the landlord whose only function is to receive the rent; the money-lender and banker, who supplies the funds to the ryot; and the ryot, who cultivates the soil. In some parts of the country, comparatively limited, the landlord combines with his own functions those of banker, and in this way is not altogether a useless member of society, though under this system he obtains a dangerously great power over the ryots. Again, where there are no landlords, the common arrangement in India is that for the cultivation of the soil two parties are necessary, the ryot who cultivates the soil, and the money-lender who supplies him with funds, and does his banking for him. In this way there can be no doubt that the village majahun is a useful, and in fact a very necessary institution; very useful indeed so long as the laws are not made unduly favourable to him, and so long as he is kept in his place, and not encouraged to combine the functions of money-lender and land-owner. In the Punjaub, under the village system, the village majahun is generally a highly-prized member of the community; and among the Afghans it is not an uncommon cause of strife and war among the tribes, that one tribe has stolen and carried off another's banker, and attempted to appropriate him for their own villages. The fact is, that under our system of long settlement, by which the whole risk of seasons and variation of values and of money is thrown on the ryots, it is sarcely possible that he can carry on without recourse to a banker of some kind. I have always been much in favour of the system of grain rates, valued at short intervals, by which the farmer may be relieved from much of the excessive variations to which I have alluded.

I have now come to the cultivation of the soil, which I am afraid we hardly so well understand as we do the tenure. The great question which has been raised of late years is whether the soil is becoming exhausted at the same time that the population is rapidly increasing, so that grave and dreadful evils may be feared. The population, no doubt, is increasing, but we are still without sufficient data to show the rate of increase; nor has it been made clear whether famines are really more frequent than formerly, or whether we have only had a recent unhappy cycle of famines which may have occurred in former ages, of which we have little information. My impression is, that the exhaustion of the soil is rather a thing which there is reasonable ground for apprehending, than a fact which has yet been made apparent beyond doubt as having actually occurred on a great scale. That a process has been going on, leading to much reasonable apprehension, is, I think, patent. We acquired India after terrible troubles, which had caused very much of the land to lie waste; there were many blanks; the last two or three generations have been filling up those blanks. They found much new land, which they brought into tillage; there is comparatively little left now; there is less room for grazing, less for fallows, more people to feed, and more produce exported. No doubt the soil must be exhausted in the end, if improved methods of cultivation are not introduced. Hitherto the great panacea for everything has been irrigation; but now there are very grave doubts whether increased irrigation, without increased manure, is not too much in the nature of a mere stimulant, and does not cause exhaustion, and grave evils in the end. I think there can be no doubt of this, that limited portions of the soil are very highly and skilfully cultivated by certain classes of natives in their own way. In addition to the higher classes of ordinary native produce, I might take the case of opium, which is cultivated with a care and a skill unrivalled in the world. Again, I might instance the case of potatoes, an entirely foreign vegetable, introduced by ourselves, yet the native cultivators have learnt to cultivate them very much better than we can; but then these special cultivations depend very much on the small quantity of manure which the villages produced, and they can hardly be much extended without additional manure. In truth, we must confess that we are really extremely ignorant of agriculture. Most of us who go to India know very little about agriculture of any kind; and of agriculture under the conditions of Indian soil and climate we know nothing whatever. The consequence has been, that when we have attempted to show the natives how to improve their agriculture, we have generally egregiously failed, and, to use a native expression, our faces have been blackened. In this respect I am afraid we are not improving. The old-fashioned Civil servant, if not so literary as the new class, and, perhaps, not much more agricultural, settled down more in the country, and learned more of native agricultural

habits and ways. Present administrators, I am afraid, know very little of any kind of agriculture, and it is much the same with regard to the native public servant; formerly they knew nothing of English literature, but they knew a great deal of the country; now they are very highly educated, but do not know much more of agriculture than their European superiors. I am glad to hear that a beginning has been made of sending one or two natives to the Agricultural College in Cirencester, and I hope that will be followed up. It is true that many of the free, unofficial Europeans cultivate, very successfully, tea and indigo, but they have enough to do to apply themselves to their own special articles, and have not generally given attention to the ordinary native cultivation.

My view is, that in a country where there is not sufficient wealth, capital, and education engaged in agriculture, to insure the spontaneous improvement of the country, it is the proper function of a paternal Government to do all that it is possible for a Government to do in the way of obtaining information, introducing new staples and new methods, encouraging and instructing the farmers; and when I say this, I speak not merely of an Oriental sort of paternal Government; on the contrary, I would instance the freest of free Governments, that of the United States. As regards the cultivation of the soil, the United States may be said to be a nation of small farmers, and that being so, they have found the advantage of a Government Agricultural Department; they have a most active department of that kind, not only in the various States, but also a Central Agricultural Department of the United States, from which they believe that they derive very great benefit. I, myself, believe that they do. I have seen the very active operation of the agricultural departments. It has then been a very great grief and disappointment to me, that the agricultural department designed by Lord Mayo has turned out to be altogether a sham, and no agricultural department at all. It was made to be a mere addition to the secretariat to the Government of India, dividing with another department the same work which had hitherto been done; it was overburdened with matters entirely outside the functions of an agricultural department, and practically has done next to nothing for agriculture. Our hope was that in one province of India only something practical had been done, viz., in Madras, where we heard a great deal of the successful Government farm under Mr. Robertson. I confess to having been very much disappointed when Mr. Robertson was good enough to give this Society the benefit of his experience. It seemed to me, that in his paper he told us a great deal too much about the tenure of land, and other semi-political questions, in regard to which he cannot be considered a very special authority, and a great deal too little about practical agriculture, on which we did suppose that he was an almost unique authority. I wish then to express my very great hope that her Majesty's Government will see their way to establish in India a real department of agriculture, such as exists in America. I would not be too sanguine that a revolution in agriculture would be very rapidly effected, but I feel confident that much might be done. For instance, no plant is more widely cultivated than maize. When I was in America I was astonished to see the immense variety and greatly improved sorts of maize, which were exhibited at different places, among which the cultivation was enormously improved, whereas in India I never heard of a single soul who attempted to introduce new kinds of maize. To tell the truth, I may at once confess that I was some 30 years in the Indian service without ever knowing that there was more than one kind of maize. To take another case, it has always seemed strange that while the flax plant is one of the most widely spread productions in India, it has never been used for fibre, except, I believe, in one small corner of the hills. An attempt was made to grow flax, but that attempt was made in the Punjaub, the very driest part of India. So far as I know, it has never been attempted in Bengal, which is the moistest part, and where, I believe, linseed is most abundantly produced, though one supposes that flax grows best in a moist country. It seems to me that an agricultural department might very soon do much in the way of introducing new varieties and new staples, and that gradually some information in regard to improved methods, improved manures, and machinery fitted for small cultivators might be worked out.

As to the most profitable staple, I fear that some of our old staples do not progress. The export of sugar and silk has rather gone back; and from what I have seen of the cultivation of cotton in America, and the great aptitude of the negroes there for this cultivation, I very much doubt whether India will ever compete very successfully with America in the cotton markets of the world. I rather think that the best hope for Indian cotton is in the development of the home manufacture of the article, by which cultivator, artisan, and consumer will be benefited. On the other hand, we well know that, on the whole, there is a continual increase of exportable produce. Wheat seemed likely to become a very great staple for export; and I still hope it will be so; but the difficulty to which I have already alluded especially applies to wheat. All the alluvial soils, which grow wheat well without artificial irrigation, have already been occupied. A great extension of wheat cultivation is scarcely possible without irrigation; and some of the canal lands have certainly become very much exhausted for want of manure. The competition of cheap American wheat stands, too, much in the way. But, on the other hand, India has almost a monopoly of the rice supply of the western world, and there is no limit to the demand for rice. In rice, we wholly beat the Americans; Indian rice is now largely imported into America; we cannot, then, grow too much rice. It seems, too, that rice only needs an abundant supply of water, and that it does not exhaust the soil so much as other crops. I hope that some of the rice canals, such as that in Orissa, which have not hitherto been very successful, may succeed in the end. They have had to struggle with very great difficulties, owing to the mismanagement of the private companies who at first undertook them, and which demanded exorbitant rates before the people were ripe for them. There are also very great difficulties in the distribution of water connected with the tenure of land. I hope that there is still room for a very considerable extension of the pro-

duction of jute, oil-seeds, and similar great articles of export in Assam and some districts of Eastern Bengal, in the Central Provinces, and in some other parts of India. Putting aside here all political and moral questions, I think it may be said, as a mere agricultural question, that the opium cultivation continues to flourish, and the value of opium exported becomes larger year by year. No substitute for indigo has yet been found in coal, or anything else, and I believe that the cultivation may yet go on and prosper if the indigo planters will only avoid the rock that threatens them; that is, that they cling to a feudal system of growing indigo by compulsion, when it would be much better for all parties to give a fair price for it, and get it by free contract from free cultivators. The tea cultivation, notwithstanding its ups and downs, has been an immense success. I am afraid it is a little down at present, but I do hope that the tea planters will not be led into unfair demands upon Government for the remedy of their labour difficulty. Unhappily, there is still a very great mortality among the coolies employed in many of the tea gardens, which imperatively requires the attention of Government, in the case of coolies who are not free labourers, but bound down for terms of years, enforced by very stringent laws. No one is more for freedom of contract between employer and labourer than I am, but what I do object to is any demand for freedom for the planter, while there is no freedom for the coolie. One would suppose, from the things that are said, that the Government throw all kinds of obstacles and unnecessary restrictions in the way of the planter, while the coolies are free to do as they like. The fact is just the contrary; if a planter engages a coolie under the ordinary civil law, the Government in no way restricts him; but what the Government do say is this, that if you insist, as you have insisted, that you should have penal laws of the most stringent character to enforce civil contracts of labour by criminal processes, and by powers put into the hands of the planters themselves, then the Government must exercise a certain supervision for the protection of the coolies, who are, for the time, not free labourers at all, and are liable to be sent to the most unhealthy places and kept there. I have doubt, then, about the proposals for new legislation on the subject. My remedy for the labour difficulty, would be to give very greatly increased facilities for the transfer of labour, and the free hiring of labourers without any penal or special laws at all. I should like to see as many new roads and railways as possible, to connect the provinces with over-abundant population with those whose population is scanty. In particular, I should very much like to see a cross railway connecting the Benares and Bahar provinces through the Northern Bengal with Eastern Bengal and Assam. But the question of migration and emigration of the natives is a very broad and difficult one, on which I cannot now enter. There is still, no doubt, room for a good deal of migration in India, but it can only be carried out gradually and carefully; and I am myself much convinced that both to the people of India, and to the tropical possessions of her Majesty, very great advantages might result from an extensive Indian colonisation, if we could only make sure that Indian emigrants would be fairly treated under Colonial laws, and by Colonial admistrators, an assurance which, in my opinion, we have not yet obtained. I think emigration should be encouraged when, and only when, an Indian going to a colony is there treated in the same way as any other of her Majesty's subjects. However, I will not enter on the subject now. I am afraid I have already been too long, and I will only commend the subject of Indian land and Indian agriculture to you as being far more important to the people of India, and to all who are interested in India, than all other subjects put together. I hope that there may be fulfilled that which her Majesty's Government have put forth as their desire, namely, less of wars, and more attention to agrarian affairs.

DISCUSSION.

Sir William Robinson thought that the thanks of the meeting were due to Sir George Campbell for his suggestive paper; but he himself felt that the useful discussion of the many subjects thus discursively raised, required more preparation and opportunity for careful argument and statement of facts, than the mere listening to such a paper for the first time afforded to him. As respects the tenures of land by the ryot-proprietory of South India, he had endeavoured to explain their condition—more especially as regards the non-zemindari tracts of the country—on the occasion of discussing Mr. Robertson's paper in this room in May of last year. He had nothing to add to those observations, save that they practically apply, with few exceptions—*ex. gr.* in the Western zemindaris of North Arcot and Nellore—to the condition of landed tenures amongst ryots whose holdings are comprised within tracts of country over which a zemindari settlement still obtains. The rights and tenures of zemindari ryots are similarly, on the whole, very fairly protected against the prevalent attempts to encroach, on the part of zemindars, by the prescriptive character of the ryots' rights and titles—derived in fact from the ancient and prescriptive distribution of village land amonst the freemen of the community—by the consequences of the careful inquiry, and partial registration which preceded the introduction of the permanent settlement in most parts of the country, and by the provisions of the rent-law since enacted by the Madras Government. He would not now discuss such matters as the position of Government in relation to these tenures, "landlords," "superior proprietors," zemindari and ryotwari settlements, and the like; suffice it to say that for all practical purposes the rights and tenures of land were substantially permanent and complete throughout South India; and that this condition of the titles to land had operated so usefully that, within the last twenty-five years, the ryots had, in Madras, added at least 70 or 80 per cent. to the area of land under cultivation, and, of course, the revenue had risen—a fact which showed that the people were satisfied with their tenure, and made very good use of their land. Amongst other things, he was glad to see that Sir George did justice to the banker of India. The money-lender was spoken of as one of the great evils of India, but he thought there was no class of persons more maligned. He was, in fact, the friend of the farmer and collector of revenue alike; without this banker, cultivation could not be so actively pushed forward, or the revenue so punctually collected. It was true that the interest they demanded appeared high, but it was not higher than the accommodation was worth, nor than prevails in other poor and backward countries. In California at the present moment the small farmer did not get his money so cheap as the peasant did in India. The money-lender was a very useful member of the community, and nothing would do more harm than any legislative meddling either with his security or his position. With regard to the ex-

haustion of the soil, he thought too much was said about it; he had been a great deal through the country, and had not observed any serious deterioration, though, of course, a larger use of manure was very desirable there as elsewhere. The fact was that the extension of cultivation was bringing poorer lands under the plough. As regards rice-land, there was no doubt that irrigation brought down large quantities of silt, which was a very valuable manure. He had heard that as much as two tons of alluvial matter to the acre was brought down to Tanjore by the Cauvery, and, consequently, there was probably no exhaustion at all under this cultivation. There was probably no agricultural community in the world which was really exerting itself more heartily, and getting more out of its primitive methods of tilling the soil, than the hard-toiling Indian agriculturist. He was quite at one with Sir George as to the prospective usefulness of a real agricultural department in connection with the local Governments and Government of India, and held that widely-diffused technical instruction in the science and methods of husbandry is a primary duty. He had himself taken an active part in the movement made in this direction in South India, and looked for good, though gradual, results from all examples set to the agricultural population. Allusion had been made to the cultivation of tea and coffee, and it was a remarkable fact that directly we showed India any new product, the natives took it up at once. In the Wynaad, where we commenced the coffee cultivation about 30 years ago, the natives had followed so quickly on the steps of Europeans, that, at the present moment, the coffee land cultivated by the natives was quite equal to that cultivated by Europeans. The same with indigo; ten or fifteen years ago large houses in Madras were connected with the cultivation of this plant, but he believed the whole of this culture was now in the hands of natives. With regard to the improvement of agriculture, he did not think we should gain much by attempting to introduce English products; we should be content with endeavouring to improve the native crops suited to the country.

Mr. **Charles Campbell** agreed with Sir William Robinson that the majahun was a very useful member of Indian society. Few farmers in this country were their own bankers. In Scotland on market days the first thing the farmer did was to pay a visit to the bank. Now in India these money-lenders played exactly the same part as a banker. With regard to the exhaustion of the soil, he never really could see that there was any appreciable exhaustion going on, and it seemed to him that as long as there was a good rainfall, or the river overflowed in the usual manner, the crops were excellent, so far at least as Bengal proper was concerned. It depended on the season whether it should be a bumper crop or a bad crop. If it were a bad season, everybody was inclined to cry out about the exhaustion of the soil, but with a good rainfall one heard nothing about it. Cultivation had been going on in India for thousands of years, and if there had been exhaustion going on, he thought we must have heard of it hundreds of years ago, and there would be no production at all now, because the use of manure was very limited. He was rather doubtful about the utility of the agricultural department till we had ourselves scientifically studied the subject. In truth, we knew very little of Indian agriculture; and he did not think it could be much improved until we knew more about it. We certainly had not improved Indian art, we had improved their manufactures off the face of the earth, and if we attempted to meddle too much with agriculture, though of course immense improvement was possible, we might do the same thing. There were some things which were urgently required. For instance, the introduction of some green fodder was much wanted. Passing through Egypt, one was much struck by seeing the long lines of camels bringing in clover or vetches, or green fodder; and something of that kind was greatly wanted in Bengal. The cattle there were miserable creatures, because they had no decent grass to live upon; you could hardly call them bullocks at all, they were, in many districts of Bengal, simply skeletons. All the commons which were formerly reserved by the landholders and village communities for cattle were now cultivated, and really there was nothing at certain seasons but dirty indifferent rice straw for these miserable cattle to eat. Sir George Campbell spoke about the ryots of Lower Bengal maintaining their rights, whilst those of Behar seemed to be going to the wall; and it did seem that in Behar they were much worse off. The ryots in certain districts, chiefly in Eastern Bengal, were much better off than in many places; but in Birbhoom and Kishnagar, and other districts near Calcutta, nothing could be much worse than the state of the ryots; they were as miserable, helpless creatures as you could conceive; nothing was done for them, the landlords who received their rents living in Calcutta and squandering the money in all kinds of luxury. He recollected, about ten years ago, many of these people were dying, simply for want of water, and they lost hundreds of cattle from the same cause. He was rather in favour of the permanent settlement. His brother (Sir George Campbell) alluded to the landlords of Bengal not carrying out a landlord's duties; but he did not suppose there was any inherent difference in the landlords, whether black or white; they were all the same in reality, and if they were made to perform their duties they did so, but not otherwise. Government had never made the least attempt to make the landlord do his duty to the ryot; it had made a permanent settlement, and left landlords and the tenantry to fight it out amongst themselves. There was no registration of the rights of any class of ryots. In Lower Bengal, so far as they had managed to maintain their rights, it had been in spite of the Government and in spite of the landlords. He had lately been in Connemara, and he must say that every feature of Bengal life was there exactly reproduced, and most likely the same remedy which had been applied in Bengal would have the same effect in Ireland. There was no being on the face of the earth more practical than the Indian ryot. They all knew what jute was; it entered into every article almost of clothing, carpets, &c., but a few years ago only half a million worth came to England. The moment you showed the ryot what would pay him, he entered into it with as much spirit as an European. It was the same with sugar, in many places it was replacing the cultivation of rice. Potatoes had been mentioned, and they were grown in the district round Calcutta in large quantities for the use of the European troops. The soil was favourable, and the ryot never attempted to sow them except where they would grow successfully.

Mr. **Pfoundes** said that allusion was made in the paper to the United States Agricultural Bureau. He happened to have some information about that bureau, and also knew the opinion of intelligent Americans on the question, as well as having had, semi-officially, some experience of one of the offshoots of the United States bureau. At a heavy expense, and with a great flourish of trumpets, this bureau was planted in Japan, but he was sorry to say that the result was almost *nil* in proportion to the expense, and he should regret to see anything of the kind transplanted to India. He had some knowledge of the Colonies from 1854 to 1863, and he thought that Indians, or Chinese, or any other Asiatic who went there, would be well treated, if they were only law-abiding citizens. The self-interest of the colonists would teach them to treat them well, and besides we had English laws carried out there almost to perfection. Instead of this agricultural bureau, which might succeed fairly well in America under certain conditions, but which, transplanted, would most likely possess all the faults of American officialism and English red-tapeism brought together, he

thought it would be wiser to subsidise an Aclimatisation Society, with branches in the various provinces, and by their means a great deal might be done. When a young man, he saw something of the Climatisation Society in Melbourne and Victoria, which did great things during the first five or six years of its existence. It was necessary to be very careful in transplanting European, American, or alien ideas of any kind to Eastern countries. He spoke not so much of India as of the countries further east; but Sir Edmund Hornby, who was a great authority on matters connected with the East, on one occasion told some official Japanese gentleman, he strongly advised them in the revolution they were then entering upon, not in any way to touch the native landlords, or native agriculture—above all things to be most careful not to interfere with the native tiller of the soil.

Mr. Robert Cust, having expressed his disappointment that Sir George Campbell was not able to be present, and his high appreciation of the practical and suggestive character of the paper, said there were four distinct tenures of land in India, that of the southern part of India, which Sir William Robinson had alluded to, the Bombay Presidency, the Bengal Presidency, the North-West Provinces, and the Punjaub, in which Sir George Campbell and himself had spent so many years. There was essentially the same system of tenure there, and the officers of the State took to themselves the credit that their tenure was not a new creation of the English, but a continuation of the old institutions of the people. They did not create great landlords and nobles, as was done in Bengal; or break them up into miserable ryots, as in Bombay. They accepted the village system, and the village proprietors as the unit. They found the head men of the village representing the proprietory, and below them, cultivating tenants of two classes, those with rights of occupancy, and tenants at will. When they moved in and took the Punjaub, they came then to a virgin soil and a kindred people, and they then found the value of their system entirely confirmed. They went from village to village, and in a very short time the settlement was concluded under the same village system which had outlasted dynasties. Many of these village communities had lasted down from the Aryan immigration. He did not say that they had existed in Southern India; perhaps they did not, but they had, fortunately, been caught alive in North India, and the desire had been to perpetuate them, not to destroy them. The great secret of governing oriental countries was to let the people alone. Lord Lawrence's maxim was an easy settlement and a rapid collection, with no balances. In this way, they never had any trouble, the people knew there was so much to pay for each village, the accountant made up the accounts, and the head man paid the bill. If they attempted to interfere too much with the people, as, he was afraid, had been done in Bombay, dealing with each individual, and making the rent-roll of some thousands of individuals, it left much room for oppression on the part of native officials. In the North-West Provinces they dealt with the villages by their head men, and that was the secret of their prosperity. Everybody who had studied the tenure of India must think of Ireland, for the circumstances were, in many respects, the same, and the same remedy should be applied to both. In India they recognised that there were in the land two distinct rights—the rights of the proprietor and the rights of the tenant. Both were able to co-exist. They recognised that the landlord had a limited right in his estate, and that the tenant had his right to the produce on his paying the rent; the landlord paid the revenue to the State; by law the rights of the tenants were guaranteed, and something of the same kind would have to be done in Ireland. He agreed with what had been said about the money-lenders or bankers; the business of the country could not be carried on without them. He doubted whether it was the business of the Government to meddle with agriculture; we had enough to do to collect the revenue and keep the place; the great thing was to let the people alone, though you might have a model farm if you liked as an example. The people knew their own business best; they had been going on in this way for 2,000 years; the land never got a fallow, but it produced magnificent crops, sometimes two in one year. He believed the people were quite sharp enough to guide themselves, and he doubted whether an agricultural department would be of any use. The great enemy of India was Manchester; and if India were governed by an independent Legislature, such as the Colonies and the American States had, they would never allow their rights to be trodden down for the benefit of a great manufacturing town in England. He was convinced that India suffered from the influence of deputations coming from Manchester to the Secretary of State, and pretending that it was to the interest of India to do so and so, when it was really their own pockets they were thinking of. Indian officials, whatever their faults might be, stood up for the people of India, and he hoped that the feeling would grow, that India ought to be considered as a great empire of itself, and not merely as a province of England.

Mr. Pal Chowdhuri said as he came from Bengal, he would state what the land system of that district was. By the permanent settlement, the zemindaris held large tracts of land, the rent of which was fixed, and they let it to the actual cultivators. These cultivators held the land under two different systems, one what was called the lease system, where the land was leased out permanently, or for a certain length of time, and another system under which the tenant only occupied for one year, and when the crop was over, he might, if he liked, leave that piece of land and go to another. There were a good many villages where there was no fallow land at all, and there the ryot would be obliged to cultivate the same piece of land again. There in such places the lease system was more prevalent, but leases again might be permanent or temporary. Where it was permanent, the rent could not be enhanced by the zemindaris, but by the temporary lease at the termination of the lease the rent might be raised or not, according to the condition of the village and the land. He agreed with Sir William Robinson that the money-lenders were most useful members of society, especially in Bengal, where the rent was payable at a certain fixed date, and if the owner did not pay, his property must be sold, so he was obliged to collect the rent from the ryots. If there were no such class as these money-lenders, property would be continually passing from hand to hand by forced sale. He agreed that there were some who did not treat their customers very well, but on the other hand some were very lenient, and went on lending to persons who could not pay their debts even for years. If there were a few persons in a village who could not pay their debts, the money-lender could not stop lending to them again, or the whole village would come to him and insist on his helping those poor persons. With regard to high cultivation, he did not know whether the time was come when it could be introduced into India profitably. Of course manuring and high farming increased the produce, but if a farmer could cultivate a piece of land for ten rupees which yielded him fifteen, he then got five as his nett profit. If he cultivated it highly, it would cost him twenty rupees, and instead of fifteen he would get twenty-seven, which would give him a nett profit of seven rupees from the same piece of land instead of five; although his profit was increased by two rupees, he had spent twenty instead ten, so that the per-centage of profit was decreased from fifty per cent. to thirty-five per cent.; and as there were plenty of fallow lands not yet cultivated, it would pay him better to take another piece equal to the former, and expend the extra ten rupees upon that, in which case he would still get his fifty

per cent. profit. So long as labour was cheap and land abundant, he did not think high cultivation would be profitable, though no doubt the time would come when the European system would be necessary.

Mr. A. Rogers (late member of the Bombay Council) said the presidency of Bombay had been much looked down upon by some speakers, and described almost as a sink of iniquity, in which the rights of everybody had been ignored, but he could assure them that that was by no means the case. Where they had found proprietory rights existing these had been preserved, and it was by no means the case that a simple ryotwari tenure existed throughout the whole Bombay presidency. When the country was first taken over, it was not found that there were hereditary farmers to any great extent, but those who paid the revenue of the villages were persons to whom the right of levying the rent had been let out by the Government of the day; but where they were hereditary their rights had been preserved. The system amongst the Mahrattas was that of farming out the revenues to the highest bidders, who were often court parasites. When the new system was introduced, they endeavoured to protect the ryots against the exactions of those who were merely farmers of the revenue, and that was how it came to pass that the village system broke up in some parts of Bombay. This was specially the case in the Deccan, and in a portion of Guzerat. Having had a great deal to do with the land settlement, he could say that a system was introduced which enabled each man to stand on his own feet, and work for himself, which had been of the greatest importance to the people. In many cases they had rescued the agriculturists from virtual slavery. There were certain classes who were called Nirwadars, in Ahmedabad, Bhagdhars, in Broach, and Talukdhars, who had certain proprietory rights, which had been preserved; but under these heads of villages there were other tenants, who had rights adverse to them — tenants who had customary rights, just as there were in other parts of India, and those had been most strictly preserved. With regard to the introduction of the agricultural department, he thought they should be very careful how they attempted to interfere with the systems of native agriculture. The natives knew very well how to take care of themselves. Much had been said about introducing the system of deep ploughing, but he thought it should not be attempted except with very great caution. Such a system had never existed in India, but if it had been the right system, he thought the natives would have found it out before now. There were, doubtless, fertilising principles lying deep in the soil which, if they were turned up to the surface, and exposed to the sun for seven out of the twelve months, would disappear; whereas, now nature provided that they should remain deep in the soil, and provided the plants with sufficiently long tap roots to reach them. He also agreed with the usefulness of the majahun.

Mr. Shore desired to say a word or two on the land system of Orissa, a province very interesting in many respects, both from its natural features, and the state of things existing when the English conquered the country. It offered a contrast to the rest of Bengal, in this respect, that it had not been subjected to the permanent settlement. They had certainly committed the same error—if it was an error—to some extent which Lord Cornwallis, or the previous Governor of Bengal, committed, in recognising at once the classes which were employed in collecting the revenue as the proprietors of the land. It was quite true that in the permanent settlement it was stated that the rights of the ryots were to be ascertained and recorded; but that was not done. In Orissa there were more hereditary rights on the part of the zemindars than in Bengal, because the country had never been so thoroughly conquered by outsiders. At first they made a great bungle of it; and partly in consequence of the oppressive demands made on the land, there was a great rebellion in 1815, which opened their eyes to the necessity of preserving the rights of the people, and eventually very detailed and minute settlements were made, the principle of which was exactly the same as seems to have been recognised in theory in Bengal, although not in practice, and had been carried out in Bombay. They recognised the rights of the landholder as being hereditary and indefeasible so long as he paid the revenue to the Government, but they took care to insure the rights of those who cultivated under him. There were two descriptions of ryots, tenants at will, and hereditary resident ryots, the latter of whom had their property absolutely secured to them as long as they paid their rent, which could not be increased by the zemindars by one farthing, and in addition to the land for which they paid rent they were allowed to have a considerable homestead free from rent. These people had stood the pressure very well of the demands upon them. The non-resident ryots had not these advantages, and might have their rents raised upon them, not only by the proprietors, but by the middle men, of whom there were several classes, some of whom had a per-centage of 30 or 35 per cent. of the produce of the rents, and others a smaller quantity. This system, on the whole, had stood the test of experience extremely well. When he first went to the country, there was a good deal of fallow land, and at that time, instead of their being any competition for land, the great proprietors competed with each other for ryots, and, in some cases, actually created resident ryots, and gave them homesteads, though, in the majority of cases, it was the tenants at will whom they desired to have on their land, and he had even known cases of affrays between adjacent proprietors for the possession of these ryots. In consequence, however, of the increase in population and so forth, the position of things was now reversed, and the competition was now more for land than for tenants. There was another peculiar tenure in the southern part of Orissa, in the sacred district, near the Temple of Juggernaut. There were enormous villages of Brahmins, who held the whole of a village in common, subject to a very small quit rent, in some places paying nothing at all. These men were most determined in the maintenance of their rights, and Mr. Sterling some years ago stated that they were the most hardened and stubborn set he had ever met with. He should say that they were an independent and fine set of men. The land revenue settlement was really the key to the whole agricultural system of India. Where it had been too heavy, land had gone out of cultivation, and the people had been oppressed and miserable; where it was almost non-existent, the people had grown idle and become extravagant; but where the burden had been fairly distributed and tolerably light, the condition of the people had been better than where there was no revenue at all. The admirable results of the detailed field assessments in Orissa were very much felt. The advantage of recording and preserving the rights of the natives was so much felt that something of the same kind was done in Bengal, by Aitkin, in 1859. It first gave rise to innumerable law suits, but everything had now settled down. The two great points were that they recognised distinctly, both the resident ryots and the rights of occupancy. The resident ryots were those who had held for a certain number of years at the same rent, and they could never have their rent raised; whilst the rights of occupancy were preserved to those who had been twelve years in the possession of the same land, and their rent could not be raised above the general rate of the country, which had a good effect in restraining the rack rent system of Bengal, which seemed to operate in precisely the same way as it did in Ireland.

Mr. Long said, with regard to the village system, it was now twenty years ago since he passed some time in the interior of Russia with one of the noblemen whom

the late Emperor employed to carry out the serf emancipation, and the system which had prevailed in India from time immemorial had prevailed in Russia for 2,000 years, and had worked wonders. Had that system been developed further, we should not have had the events which occurred lately, but, unfortunately, it stopped, and a reactionary system took place. Each village had a representative, and these representatives met in a sort of county assembly, and that led up to a provincial assembly. It should have been carried further to a national assembly, but that was not attempted; still immense good had been done in Russia by the system. With regard to the Bengal ryots, they owed an immense debt of gratitude to Sir George Campbell, who, in the face of much opposition by the educated classes, because he was the friend of the ryot, carried out reforms which would carry his name, with that of Sir J. P. Grant, down to posterity as the benefactors of Bengal.

General Maclagan, R.E., with reference to the remarks which had been made regarding exhaustion of the soil in India, did not think they had yet sufficient systematic data to form any conclusion on this subject. But there was one matter which greatly affected the produce of the land in certain parts of the North-West Provinces and the Punjaub, which had not been alluded to, and that was, that a certain injurious salt, called *reh*, made its appearance on the surface of the ground, and threw large areas out of cultivation. It has appeared extensively on lands irrigated by canals, and particularly where the irrigation channel was a little above the level of the country. The water sank into the ground and percolating there arose to the surface carrying with it this injurious salt. The *reh* is chiefly sulphate of soda. It has sometimes been supposed to be in the canal water, but the same water irrigates other lands without producting *reh*. It appears to be in the soil, and to be brought to the surface by the water. When near the surface, it comes out after rain, as it does in ravines in the neighbourhood of Lahore. Colonel Sir W. Sleeman, in his "Tour in Oudh," mentions the occurrence of *reh* in that province on cultivated lands, and describes the remedy there adopted, which was to divide the field into very small portions with little raised banks between; these were flooded with water, which gradually sank into the soil, carrying the salt with it, sufficiently to allow at least one crop to be raised, and, when necessary, the process was repeated. Of the lands which have been watered by the Western Jumna Canal, there are many square miles on which, from this cause, no crops can be grown, and on which the *reh* is so copious as to have the appearance of snow. On *reh* land it has been found that certain kinds of vegetables can be grown, but, speaking generally, the land so afflicted is thrown out of cultivation. The matter has attracted much notice, and the "deterioration of lands from *reh*" has been the subject of much correspondence. It continues to receive attention as a matter of some scientific interest, as well as practical importance.

The Chairman said he thought it was impossible for any one who had not had to deal with the land revenue in India to give any opinion on the subject of land tenure worth listening to, and not having had that advantage, he would not touch on that point; but with reference to the remarks made on the subject of agriculture, he was strongly of opinion that the natives had a good deal to learn, and he concurred in the views of Sir George Campbell. Most of the gentlemen present held a different opinion, and seemed to think the natives had very little to learn; but still, from their own remarks, he thought their conclusions might be disputed. They said the natives were very quick to learn, and when a European introduced a new process, they immediately caught it up, which evidently showed that they could be taught, and were being taught. He was much struck some years ago by a dispatch written by the late Lord Mayo on the 6th of April, 1870, from which he would read a few sentences. Lord Mayo said that, "of all branches of Indian industry, agriculture, which constituted the occupation of the great mass of the people, was by far the most important, and he believed it to be susceptible of almost indefinite improvement." Again he said, "for many generations to come, the progress of India in wealth and civilisation must be directly dependent on her progress in agriculture;" and again, "it was hardly too much to say that a scientific knowledge of agriculture in India had not at present any existence." Those were very strong words; and many old Indians with whom he was acquainted said they were incorrect; but, on the other hand, many others who were well versed in agricultural matters, considered them perfectly true. He did think there was much to be done in the way of improving agriculture in India.

Mr. Long said he was for several years a member of the Council of Agriculture; and they found the natives were very careful in learning, but they did not understand principles.

The Chairman said some gentlemen had spoken as if there were an idea of compulsion in this matter; but nothing of the kind was ever dreamt of. All they wished to do was to show what could be done, and leave the natives to follow what appeared to be for their good. A relative of his own, when home some years ago, went through a regular course of agriculture at Cirencester, and he heard he had recently been giving lectures on agriculture in Katimour, and hoped good would result from them. He must take exception to the remarks of Mr. Cust, who had attacked his old friends in Manchester. What harm had they done? The only harm they could have done was in depriving India of a portion of revenue from import duties; but surely if Manchester had given India goods 5 per cent. cheaper than before, it was a very good thing for the consumer. Again, if Manchester sent large quantities of cotton goods there, she imported large quantities of cotton in return, and had greatly increased the demand for its cultivation in India. Speaking from some personal knowledge, he could state that no part of the kingdom had been more earnest in pressing on the Indian Government the necessity of constructing works of irrigation, railways, and every improvement of that description, than Manchester. The men of Manchester were no more selfish than other people, and he could only say that if India had men as energetic, as enterprising, and as industrious as they were, she would do exceedingly well. In conclusion, he proposed a vote of thanks to Sir George Campbell for his interesting paper.

The motion was carried unanimously, and the proceedings terminated.

SEVENTEENTH ORDINARY MEETING.

Wednesday, March 30th, 1881; C. W. Siemens, LL.D., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Culley, William Richard, 15, Maryon-road, Charlton, S.E.
Dale, George Williams Melville, Ellerslie, Nether-street, North Finchley, N.
Davis, Moses, 27, Wellclose-square, E.
Knight, William Duncan, Avening-house, Greenhill, Hampstead, N.W.
Mackie, John, 2, Victoria-villas, Queen's-road, Reading.
Pope, Joseph John, M.R.C.S., 4, South-crescent, Bedford-square, W.C.
Rowan, Arthur Hill, 6, Westminster-chambers, S.W.
Thornhill, W. George, 36, Eastbourne-terrace, W.

The following candidates were balloted for, and duly elected members of the Society:—

Adlam, James, 28, Aldebert-ter., Clapham-road, S.W.
Beaumont, Colonel F., R.E., 3, Victoria-street, Westminster.
Browne, Harold C. Gore, M.A., 6, New-square, Lincoln's-inn, W.C.
D'Avigdor, E. Henry, B.A., Derwentwater-house, Acton, W., and 15, Great George-street, S.W.
Donaldson, J. Hunter, 176, Oxford-street, W.
Greenhough, David William, 9, Mincing-lane, E.C.
Henry, Ebenezer Walker, 27, Belsize-crescent, Hampstead, N.W.
Maberly, Capt. Thomas Astley, 25, Parliament-street, S.W.
Mansfield, George, 104, New Bond-street, W.
Potts, Benjamin L. F., A.M.I.C.E., 174, Camberwell-grove, S.E.
Price, John Edward, F.S.A., 60, Albion-road, Stoke Newington, N.
Welsh, Thomas Debell, 79, Arthur-road, Brixton, S.W.

The paper read was—

RECENT ADVANCES IN ELECTRIC LIGHTING.

By W. H. Preece.

I am here this evening to describe to you the recent advances that have been made in electric lighting. My position reminds me of a story that is told of Queen Elizabeth, who, on approaching a certain town, was not received on arrival with the usual ringing of bells. On demanding the cause, the chief municipal dignitary informed her Majesty that there were 39 reasons why the bells did not ring, the first of which alone satisfied her Majesty, viz., "there were no bells." So I can almost say "there are no recent advances in electric lighting to chronicle." The advances that have been made have not been so much in electric lighting itself as in the popular favour with which it is regarded. The public is becoming more accustomed to its use, and therefore acquiring more confidence in this mode of producing light.

Electricity and gas are playing a see-saw game. As the electric light goes up, the gas goes down. It reminds one very much of those old Dutch weather houses that used to be common many years ago, but have recently disappeared. When the weather was fine, out came the old woman; when the weather was damp, out came the old man. Electricity made a great splutter in Paris; down went the gas shares. Mr. Sugg and his inventions brought the gas shares up again. An alarming message is received from New York; down goes the gas again. The friends of gas have scarcely had time to recover themselves when the City of London, with great wisdom and foresight, votes a very large sum of money to be expended in carrying out a gigantic electric lighting experiment, and this has brought the old man out once more.

The result of trials during the last year or two have been to give experience in the vagaries and capriciousness of this light. Its defects have become better known. We have been taken out of the experimental, and have been brought within reach of the practical stage. Now details are being elaborated, mechanical appliances supplied, and much useful knowledge is being acquired by those who have had the enterprise and the farsightedness to launch their money in this new venture.

The progress of electric lighting can be looked at from three points of view—scientific, commercial, and practical.

My task has been rendered very light, by the admirable series of Cantor lectures that have recently been delivered in this room by Professor Adams. He has thus enabled me to shake myself away from scientific detail, and to deal more with commercial and practical generalities. I will, therefore, glance rapidly at the commercial and practical developments of the principal portions of the system which together make up electric lighting. Let us first take the motor, the power by which scientific skill has enabled us to convert a source of energy into another form. The problem we have to solve is how to extract the greatest amount of light out of a lump of coal. Of our agents to help us, the poor old engine is much neglected. When I think of the work done by that willing slave, the engine, I am reminded of the story of the organist and the organ-blower. The blower one Sunday said to the organist, "How magnificently we played Handel's . . . . . to-day!" "'*We* played,'" replied the organist, "You impertinent fellow, what do you mean by "we played?'" The blower said not a word, but on the next occasion when the organist wished to play, the blower declined to exert himself, and on being remonstrated with, he said, "Do we play, or do we not play?" The organist said, "Yes, we do play," and instantly the organ pealed forth. So with the engine, where should we be without the engine? The reason why the electric light has, within the last few years, come so much to the front, is because electricity has been produced by the direct conversion of mechanical energy into electricity, instead of by means of batteries, which were the only sources known years ago. Now, thanks to the steam-engine, we are able to fulfil all those requirements that enable us to produce cheap electricity. Those requirements are high velocity, great steadiness, and uniform pressure; and those are the points which are gradually being acquired in the steam-engine produced from our workshops. The velocity of 800 revolutions per minute, sometimes even of double that rate, is an enormous velocity to maintain, but it is essential for cheap electricity. Eight hundred revolutions a minute need not frighten us, for we care not what the speed of rotation is, in the wheels of our express trains. No one troubles his head much about the tremendous velocity acquired by a carriage that runs continuously for 24 hours or more, and, therefore, we need not be alarmed at the velocity acquired by our stationary engines working electro-dynamo machines. It is not too much to say that what little success belongs to the electric light on the Thames Embankment, is due to the engine planted beneath Charing-cross bridge, by Messrs. Ransome, Sims, and Head. Nor should I say that the success of the electric light in the British Museum is due any the less to the Wallis and Steven's engine than to the magnificent apparatus put up by Siemens Brohers. It would be invidious to name the different engineers who have brought out special engines for this purpose, for their name is legion. Marshalls, Brotherhoods, Robey, and

others have worked hard in this field, and have succeded in producing engines which, by automatic governors and by other means, provide all the requirements that the electric light demands. It would be difficult to over-estimate the good that has been done in this direction by the competitive trials instituted by the Royal Agricultural Society. The small engines that distinguish English engineers, are almost entirely due to the interest excited by these annual trials. Instead of one-horse power requiring 7 lbs. and 8 lbs. of coal to produce it, it is common now to find engineers producing one-horse power by even 3 lbs. of coal, and in some engines 2 lbs. per horse-power has even been attained. It is strange that nothing has been done to supersede steam as a generator of power. It is well-known that the specific heat of water is higher than that of every known substance, and it is not beyond the reach of theory to assert that there are other liquids whose evaporation should produce the same power with a very much less expenditure of fuel. There is a vast field for invention in this direction. The gas-engine is a very economical source of energy, and has been very successfully applied to electric lighting in many places. At the Docks in Newport, South Wales, a gas-engine has been in use for nearly two years with great success; and it is worthy of note that if 100 cubic feet of gas per hour gives a candle power of 300, that same gas applied to an engine would give, in electricity, a candle power more than 11 times greater, namely, 3,750 candles. Here is a sphere to maintain gas dividends.

Water is another convenient source of energy, when you can find it available. Sir William Armstrong, at Craigside, near Newcastle, has utilised a brook for this purpose, and, by the aid of a turbine, produces a force giving six-horse power; in fact, he says "the brook lights his house."

I am not aware yet of air having been utilised for this purpose, except when heated in the caloric engine in use at the Lizard Lighthouse, which is found to be economical, useful, and very suitable for such isolated places where it is difficult to provide water. It is, therefore, clear that some advances have been made in the economy and the adaptability of motors for electro-dynamo machines to produce the electric light.

With regard to the generator of electricity, the instrument by which the energy of steam or water is converted into electricity, after Professor Adams, not much remains for me to say. There are several excellent machines. The difference between each is very much the difference between tweedledum and tweedledee. Each is specially adapted for its own particular work, either by a variation in velocity, or by a variation in the way in which the wire is wound, so as to produce a variation in the current produced to suit the particular light required. The efficiency of any machine is the amount of energy which is converted into current, and it has been shown that both in the Siemens and the Gramme machines nearly 90 per cent. of the power is converted into useful current. It is easily demonstrable that there is economy in the use of small machines, and it is difficult to understand the reasons that induce some people to speak of the value of the enormous machines that have been constructed in America. In fact, in this department, a great deal of time and energy is being wasted in trying to gild refined gold. Changes are being introduced for the mere sake of change. The improvements that have been made have been improvements in detail only. Broadly speaking, there are two classes of machines, those which produce continuous currents, and those which produce alternate currents. Very little advance has been made in the efficiency of the earliest forms in every case; and I learn from Mr. Douglass, of the Trinity-house, that the original Holmes magneto-electric is still in use, and doing good work, at the Souter Point and South Foreland lighhouses, and that a De Meritens magneto-electric alternating current machine, of similar type, has been under trial at the Lizard for the last four months, and that he is greatly pleased with its efficiency and reliability. The De Meritens machine is an excellent one, and one of which we shall hear more. The trials made for the Trinity-house showed that more efficiency was obtained by joining up small machines in multiple arc, than either by the use of a larger machine, or by the same machines joined up in series. This is a point that has escaped the notice of recent experimenters in this direction, and it is well worth their serious consideration.

The battery has been discarded as a generator of electricity from its want of economy, but there are hopes that secondary batteries will be introduced for the purpose of storing-up this force. No advance has yet been made, however, towards the practical attainment of this desire. Many attempts have also been made to utilise the thermopile, but in all cases it has been shown that the electromotive force produced is too low. The thermopile has this advantage, that it is wonderfully durable. I saw, last week, one which has been in use for four years uninterruptedly, night and day, without intermission, and it still gives out electricity with all its pristine vigour.

The conductor is the broad road along which electricity flows to produce light at a given point. In all cases, from its superior conductivity, copper has been selected. Sometimes this copper wire has been carried overhead and sometimes underground. Where it can be carried overhead, it has the advantage over underground that, as the heat radiates into the open air, the wire itself becomes cooler and conveys more electricity. In practice, the purest copper is used, and wire of the largest dimensions consonant with economy, for the resistance or obstruction to the flow of electricity must be maintained as low as possible, to prevent waste of energy. In the different experiments which have been carried out in London, one feature noticeable to me has been in some cases the utter ignoring of the experience gained in telegraphy. The way in which wires are suspended, and hung, and moved about, is to the mind of the telegraphist simply disheartening and appalling. On the Metropolitan Railway the wires were so decayed, and rotten, and ill-used, that they had to be removed, and the lighting of the Victoria Station of the Underground Railway was abandoned. The currents used for electric lighting are more than 3,000 times greater than those used for telegraphs. We have great difficulty in maintaining the small currents used in telegraphy along their proper course, and the

small defects that have, in thirty years' experience, made themselves evident to us, are simply magnified in their hurtful effects 3,000 times when applied to electric lighting currents.

Electric currents have also a peculiar and serious influence on wires passing in their neighbourhood. It is an influence called induction, and one that produces serious disturbing effects. In fact, so powerful are these disturbing effects, that very great fears are entertained that it will be impossible to maintain electric light and telegraph circuits close together. Recently at Holyhead telegraph communication was completely broken down along a wire that ran side by side with the wires conveying an electric light, during the time the current flowed to produce the light. We of the Post-office are watching carefully for any interference by electric light currents in this respect.

Why do electric currents produce light? Light and heat are mere terms given to what are really similar operations. Certain undulations impinge on the retina of the eye, and give that sensation which we call light. They fall on our skin, and produce the sensation of warmth. They are incident on certain salts of silver, and produce photographic pictures. The flow of electricity means the generation of heat. The production of light is the accompaniment of intense heat. In fact, the brighter the light, the intenser the heat. The art of producing brilliant light is the art of producing high temperature. There is no greater illusion extant than that the electric light is a cold light. The electric arc is the greatest source of heat known. Our worthy Chairman has shown us how it can reduce to liquid the most refractory metals; and at his country house, near Tunbridge Wells, he has kept a stove-house at 70° by its aid. Professor Dewar measured the heat radiated by the light he used, and found it sufficient to produce three-horse power per minute; hence electric currents produce light because they produce intense heat.

Now, this heat can be produced either by causing the electricity to fly across an air space, in which case we have light by the arc, or by causing it to flow through a small wire, or a carbon filament, which offers obstruction to the flow, and produces light by incandescence.

We have burning to-night several specimens of each kind. The forms of arc lamps are very numerous. In every case carbon rods are opposed to each other, and they are disintegrated and consumed in the fierce blast to which they are subjected. The lower pole—the negative—acquires a temperature of 3,150° C., it is broken up and fired with a fierce bombardment of white hot molecules across the air against the upper pole—the positive—which is beaten up by incessant impacts into a higher temperature of 3,900° C., the arc itself being 4,800° C. On account of the irregularity in the character, and, therefore, the consumption of carbon, and the variation in the strength of the current, various ingenious appliances have been adopted to obtain steadiness and uniformity in action. Mechanism, clockwork, electromagnetism, gravity, and all kinds of contrivances have been called in; in fact, of arc lamps, their name is legion.

A remarkable attempt was made by Jablochkoff to dispense with mechanism altogether in his candle but though many thousands of them are in use, it is doubtful whether the candle system will be permanent, for it is expensive and wasteful. M. Jamin has recently taken a step in advance in this line, and the trial of his lamp is being eagerly watched.

We have not yet obtained perfection in the arc lamp. We want brilliance, combined with absolute steadiness, and the durability of a winter's night. Great steps have, however, been made in simplification of parts and smoothness of action; but we lack silence and steadiness.

Many of the defects of the arc light are compensated for in that of incandescence. Here we have something that is beautifully soft, absolutely noiseless, perfectly steady, a light that brightens up Nature in all her true colours and purity. I shall not readily forget a dinner party given by Mr. Spottiswoode, the President of the Royal Society, a short time ago, when his room was illuminated by Mr. Swan's lamps. It was not only fascinating, but fairylike and lovely. One felt in a dream. We have had a sample of it here, and the beauty of the light grows on you. The incandescent light is, however, at present, an expensive luxury. It requires a considerable expenditure of power. For instance, Sir W. Armstrong finds that six-horse power supplies 37 lights, giving altogether 925 candles. Six-horse power in arc lights would give over six thousand candles. However, we must not grumble. Rapid progress is being made in this field. Maxim, Edison, &c., in America; Swan, Lane-Fox, and others, in England, are working hard, while Gordon and Joel are working in an intermediate field, where a prospect appears of a happy compromise being affected between the arc and incandescence. We have, to-night, an illustration of the burning of the Joel lamp—a modification of that introduced by Mr. Werdermann.

A good many wild statements are made about the light-giving power of these different lamps. A standard sperm candle may be a very good unit to measure gas by, but it is a very poor standard for the electric light. Of course the advocates of the electric light over-estimate their case. It would not be human nature if they did not; but their divergences are wonderful. Thus, the Glasgow committee makes one horse-power produce 600 candles; the Trinity House, 1,254; a Paris commission, 2,500; a certain Anglo-American Light Company, an unknown quantity!

We have two natural standards to refer to, sunlight and moonlight. We have various physical forces to appeal to for measurement, photographic records, the production of heat, the estimation of shadows, &c., but the standard of the future remains an *ignis fatuus*. To estimate the value of a light, you must not look at it; you must turn your back to it; you must try and read small print by it, and then you will find what a godsend it would be to find some means by which we could estimate the illumination of a square foot or a square yard. We want not only a new standard of light, but we want a new system of photometry. Efforts have been made to estimate the intensity of the light radiated by the size of the craters found on the carbon rods; but this mode of measurement is empirical and illusory, for it varies with the character of the carbons and the currents used.

A word about that "philosopher's stone," that *elixir vitæ*, the subdivision of the electric light.

What does it mean? It means that certain gentlemen hope, from one central spot, to distribute electricity, as they do gas and water, throughout our houses, so as to furnish great cities with cheap, pure, and abundant light. "'Tis a consummation devoutly to be wished." Now I am one of those who do not believe in the word "impossible," but I say, that with our present knowledge, this problem is insoluble. There are those who don't say so, but who think I am an obstructive lunatic. But what are the facts? Numbers, thoughts, words, can be manipulated anyhow—hence Whig and Tory, High Church and Low Church, *et hoc genus omne*, but facts are inexorable. Sir William Armstrong, can only keep 37 lights going; Lane Fox could only show 12 lights; Professor Adams could only produce from the most powerful dynamo-machine, by calculation, 140 lamps. Where is the subdivision? The advocates of subdivision assume an inexhaustible source of electricity. Their opponents reply that there is but a very limited source of energy in every dynamo-machine. Subdivision means loss of power, waste of energy, and useless expenditure. We are not all Sir William Armstrongs, who can say of his brook, "I can afford to waste that which costs me nothing." One ardent disciple of subdivision says, "There is practically no loss in dividing the electric light produced by this means (by incandescence)." Now, is the production of 925 candles when you ought to have 6,000 no loss? Is the production of 3,600 candles on the Thames-embankment, where you ought to have 25,000, no loss? Our dynamo-machines have their limit, and no power on earth, either of subdivision or of multiplication, can make the machine do more than a given amount of work. It may be that in course of time, and, probably, very soon too, more powerful machines and lamps of lower resistance, may enable us to light up a greater number on one circuit, but this is not subdivision, it is multiplication. I anticipate more advantages from the transmission of power, and I look forward to the day when I shall have in my own house a small and simple dynamo-machine, working my own lamps, and no one else's. I have not the slightest ambition to be dependent on electric currents generated miles away, and liable to all the interruptions to which I, as a telegraph engineer, have had long and painful experience.

Now, having got our light, the next question is, how can we utilise it? This question, as far as external illumination is concerned, is about to be solved for us in a very interesting way by the City authorities. We have, first, the centralised system of Dr. Siemens, where one machine works one powerful light, raised like a small moon upon the top of a high mast; and we have, secondly, the distributed system of the Brush Company, who utilise the existing street lamp-posts, one machine working many lights. I have no doubt myself, from my own observations, that for symmetrical spaces, large areas, such as docks, parades, squares, &c., the former is the best; but for long and narrow streets and thoroughfares, the latter will prove superior.

The same arguments apply for internal illumination. Nothing can be more perfect than the centralised system at the British Museum, while the distributed system would alone meet the case of such a place as the Waterloo Railway Station. For the former we want height and space; for the latter, length and lowness. In fact, the longer and lower the place to be illuminated, the less is the intensity of the light required; and when we come to long rooms and passages, we possess all we require in the small incandescent lamps. It is not difficult to show that such conditions may arise, even in external illumination, that a few small lamps, well distributed, will illuminate better than one or two powerful ones.

An eventful feature in practical lighting is the proper scattering or diffusion of light, by shades, screens, and reflecting surfaces. There is an archway at Waterloo Station that is wonderfully lighted, owing to the white glazed tiles on its sides, forming such admirably reflecting surfaces. We want to emulate the diffusion of daylight. It is marvellous how whitewashed surfaces do this. Well selected globes act as though they were self-luminous—they scatter light and prevent shadows.

The reason why daylight is so diffused, and the light searches out the inmost corner of our cupboards and our drawers, is simply that practically the whole sky becomes the source of illumination, light radiating from each point. One interesting question that will be solved by the great experiment commencing to-morrow in the City, will be the relative efficiency of different lights in penetrating fogs. It is a point open to the observation of every one of us, that the electric light upon the Thames-embankment exhibits no more power in penetrating fogs than gaslight. The reason of this is extremly simple. Light, as I have previously explained, is due to the undulation of matter. There are waves and waves; some like the mighty ocean swell, tossing the *Great Eastern* like a cork in a basin; others are reflected from the side of the cork, as the billows of a storm are tossed back by a solid pier. The colour of the sky is due to the reflection of the tiny blue waves, by excessively minute material particles floating about. The red sky at night is due to the unimpeded transmission of the larger red waves, the smaller ones being checked; hence the dull red of the round sun in a mist, and the destruction of the smaller rays of the electric light, which lend it that bright and brilliant violet tint in clear weather. For the same reason that the penetration of the electric light is no greater than gas, its illuminating power in its immediate neighbourhood is more. For these small rays which had been checked by material particles from penetration are reflected back to the immediate neighbourhood of the light. There is a great difference between the quantity and the intensity of light. There may be light of very low intensity, but yet of such large quantity as to penetrate to a considerable distance. A ship on fire at sea, for instance, is seen to an enormous distance; and it must not be forgotten that the law of squares, by which the relative intensity of light is determined, is true only for points; it is not true for surfaces. A large flame of gas, though its intensity is so much less, may be as luminant as a point of electric light. Beacon fires, though of very low intensity, are visible very far. In fact, if we increase the luminous area as we recede from it in proper ratio, we shall maintain the same amount of illumination; hence the great failure of photometric measurements to which I have

alluded. A photometer measures the intensity of light, not its quantity.

It is important to acquire some experience from the actual users of the electric light, and to know what amount of business has already been done. For instance, there are nearly 300 Gramme machines in use in England generating light. There are many more Siemens's, while the Brush people have already installed many machines and lights.

The Trinity-house, who have applied the electric light to lighthouse purposes, have at present confined its use to Souter Point, South Foreland, and the Lizard. They find that the expense involved in the installation of the light is very considerable, and it cannot be adopted without very strong and powerful reasons. Perhaps the greatest extension in the use of the light has been for naval purposes. Nearly all our present ironclads are supplied with the electric light. The last addition to this list, the *Inflexible*, will have no less than two Brush machines, each producing sixteen lights. These machines will be arranged to work together or separately. There will be lamps in the citadel, in the engine and boiler-rooms, in the steering platform, below the torpedo department, in the magazine and shell-rooms; they will be used for buoy lights and mast-head lights, and probably, as there will be plenty of accommodation on board for the production of electricity, the cabins will be lighted with some incandescent lamps. The *Minotaur*, again, is fitted with sixteen Brush lamps; and, in fact, for torpedo purposes, the light is not only useful, but absolutely essential. Last year I had the pleasure of spending some time in the Mediterranean on board a ship laying a submarine cable between Marseilles and Algiers. Our operations were carried on by night as comfortably as by day, by the aid of the electric light.

Libraries, again, have become a useful field. Reading by gaslight is irksome; reading by the electric light is simply delightful. The Picton Gallery at Liverpool has been so lit for a long time, and the British Museum is now permanently illuminated by five arc lights, which fully answer the purpose. This has enabled the authorities to keep the reading-room open daily through the winter till seven o'clock, and only on one day (and that within a short time of the hour of closing) have the lamps failed, the failure being due to a want of proper fuel for the engines. At South Kensington 32 Brush lights are used with great success, and afford every satisfaction, not only as a luminant, but in an economical sense.

Railway stations are gradually adopting the lights. The Liverpool-street Station of the Great Eastern, the Paddington Station of the Great Western, the Waterloo-bridge Station of the London and South Western, the Charing-cross Station of the South Eastern, the Bricklayer's Arms (Goods) Station of the South Eastern, are being practically and effectively lit, and the St. Enoch's and Queen-street Stations at Glasgow, as well as the Victoria Station at Manchester, are equally successfully being lit.

Again, we find seaside resorts availing themselves of it for the illumination of their parades. Blackpool, for instance, has, with great enterprise, lit up the whole of its parade and piers with great success.

The new Albert Docks on the Thames, the Alexandra Dock at Newport, the Mersey Docks at Liverpool, are all spreading the use of this light with considerable speed. I was surprised last year to find the Belle Vue Gardens at Manchester (a pleasure resort that reminded me very much of the old Surrey Gardens we used to have in London), where, without any expert assistance, the active managers, the Brothers Jennison, had rigged up several lights themselves, and had experienced neither trouble nor difficulty in the matter.

It would be impossible to make any summary of the numerous works, mills, dye works, &c., that have been supplied with lights worked successfully. The Iron Works at Barrow, for instance, have very extensively employed it; while the *Times* office was probably the first place in London to inaugurate the introduction of the electric light for such purposes. Shops and warehouses in all parts of the country are now being lit up—Whiteley's, Shoolbred's, Nicholl's, Regent-street, Crocker's warehouses in Friday-street, and many other places, and now we find the City inaugurating the illumination of their streets and open spaces. I never pass that wretched excrescence that indicates the site of old Temple Bar, without wishing that the heraldic beast that surmounts it were removed, and supplanted by a handsome bronze pillar 30 or 40 feet high carrying a miniature sun. It would not only make the memorial more ornamental, but it would make it useful as well.

One of the most useful purposes to which the light has been applied, is that of photography. Not only are pictures taken by its aid in the wretched fogs of winter, that quite destroy the actinic power of sun rays, but it is used to a very large extent in carrying out what is known as the Woodbury process. The electric light is not so powerful as sunlight, *i.e.*, it does not operate with the same rapidity. Electric light takes, in fact, three times as long to print gelatine reliefs for the Woodbury process, as the sun; but Messrs. Lock and Whitfield assure me that they hardly know what they should have done during the past sunless winter without its aid. Whether the exposure is for one hour in the sun, or three hours in the electric light, is a matter of no consequence, if the quality of the results are similar; the sun, however, has an advantage, due, doubtless, to the greater quantity of light that it emits.

Perhaps, however. the most interesting appliance from a scientific rather than a commercial point of view, is the application, by our worthy Chairman, of this light to horticultural purposes. He has found that it fulfils all the requirements for the growth of plants and ripening of fruits; and he has at his country seat, near Tunbridge Wells, carried on a very large series of experiments, that have created quite a sensation in the scientific world.

Notwithstanding these great advances in its use, it must not be forgotten that the electric light has its defects and its disadvantages. All is not gold that glitters. The intense shadows that it emits are troublesome. The unsteadiness of the light is at times wearisome. The hissing that impurities in the carbon and irregularities in the current produce is tantalising, and the light has an unfortunate habit of misbehaving itself when it is most wanted. Moreover, the pro-

blem of durability remains yet to be solved. Many have tried it and abandoned it. In some cases its economy is unquestionable; but there are places where careful persons have shown that gas, as regards economy, surpasses it. It is questionable whether, in some cases, the electric light does not affect the eye. The experience, however, of the readers of the British Museum is entirely in its favour. Nevertheless, I have myself suffered much from the light; true it was in experimentation, and the same thing might have happened with any intense light; but rumours do exist that eyes have been affected, and probably sufficient time has not yet elapsed to solve this question. The arc light produces, also, nitrous acid and other deleterious gases, as is shown in the condition of the lamps. The incandescent lamp, is, however, free from this trouble. The powerful currents that it requires cannot be carried over buildings and rooms without incurring danger from fire and to life. It has been proposed to utilise the electric light in coal mines, but, to my mind, one might as well lay a train of gunpowder along a mine gallery, if it be at all a dangerous one, as a wire conveying such powerful currents of electricity as a light needs, unless that wire be most carefully protected.

The disturbance due to induction I have already alluded to. Nevertheless, in spite of all these defects, the light has great and manifold advantages. The brilliancy of a well-lit room is simply enchanting. The purity of the light for the transaction of business, the selection of colours, and the ordinary daily avocations of life, is simply superb. The cleanliness of the light is one of its great merits. It emits no smoke; but probably its greatest advantage is to be found in the influence it exerts on health. We all know that the air is vitiated to a certain extent, by the mixture of carbonic acid with it, and it has been well shown that to be consistent with health there should be not more than six volumes of carbonic acid in ten thousand volumes of air. When the proportion reaches ten volumes to ten thousand, the action of the heart is affected. When this proportion runs up to from fifteen to thirty volumes in ten thousand, headaches occur, and in higher proportions, rheumatism and bronchitis are the consequences. Now, five thousand cubic feet of fresh air per hour per gas burner, consuming three feet per hour, are required to maintain your health; in fact, in our great galleries at the General Post-office, we require two to three million feet of fresh air per hour to provide a healthy atmosphere. The electric light sweeps away all the necessity for this ventilation. It does not vitiate the air. We have found at Glasgow, where we have applied the electric light, that all these causes of trouble have ceased. Health has been engendered, more work has been got out of men, and, in point of fact, the experience of others shows that the electric light will pay for itself even in the increased work that can be obtained out of labour in consequence of its use. Not only is the health of the subject improved, but men are able to do more work in a given time from the influence of this pure light than from the impure light of gas. We still want brilliancy combined with steadiness and durability. The advances made have not been so much in this direction, as in the improvement of details, and in a greater knowledge of electrical measurements and of the relations that exist between electricity, heat, and light. Electricity as a substitute for gas is not a delusion; it is practicable. It supplies a real want; but for domestic purposes it is at present a luxury, and an expensive one. Predictions as to its grand future have not yet been fulfilled. The public have shown themselves remarkably sensitive to its influence on gas. Nevertheless, it has a bright future before it, and, though the poet might have said—

> "It was a phantom of delight,
> When first it beamed upon my sight;
> A lovely apparition sent
> To be a moment's ornament."

—if he had lived in the present day, he would have considerably added to the period in which he estimated the electric light to be an ornament.

DISCUSSION.

The Chairman, in moving a vote of thanks to Mr. Preece for his valuable paper, said that gentleman had passed the whole subject of electric lighting in review, in a manner which must have struck home to the minds even of those among the audience who had not before given particular attention to the subject. He had followed the energy pent up in the coal in former ages through its transformations in the steam-engine and the dynamo-machine, where it was manifested as an electric current, passing through the conductor into the lamp regulator, where, through the resistance offered to its passage, heat was again generated, being the very form of energy with which they started, with the difference, however, that the heat produced in the electrodes of the lamp was of a much more intensified nature than the heat developed by the combustion of the coal. Hence, after all, electric lighting meant nothing else but carrying energy from the coal to the carbon in the lamp. But simple as the problem appeared when thus put, it had required the combined ingenuity and labour of philosophers and of practical electricians, extending not indeed over centuries but over decades; and even now a point had only been arrived at where it could be said that electric lighting was feasible. At the present day, advances were made more rapidly than had ever been the case before, and before long it might be possible to say that electric lighting was an accomplished fact. The great experiment soon to be made in the City of London would be an event of the greatest importance, and the greatest city in the world was now leading the way in utilising this new agency in a way which would leave no doubt as to its efficacy. Photometry, the sub-division of the electric light, and various applications of electricity, had also been touched upon in the paper, and though most of the propositions put forward in it would be accepted by all who understood the subject as natural facts, still, naturally enough, in so new a science, there were other points which were controvertible, and which he (the Chairman) would like to argue with Mr. Preece, but that he feared to try the patience of the meeting. They had sometimes argued questions very strongly, but had always been very good friends afterwards. If he had understood aright, Mr. Preece hoped, and great philosophers had entertained the same hope, that the divided light would ultimately equal the centralised light in economy. He begged to differ from that conclusion. Divided light meant light brought nearer to the eye, and the eye could not bear a light of such intensity in close proximity as it could bear at a distance. Mr. Preece had very well said that light was nothing but heat of the intensest kind. In order to have the greater number of light rays over heat rays emanating from a centre, it was necessary that the temperature should be raised to the utmost attainable point; even in the

electric arc, then burning in the lamp before them, probably nine-tenths of the rays emanating from that centre were not luminous, but heat rays, otherwise, even with the lamp so far removed, they would not be be able to bear the light. Although he believed that divided lights would be very largely used, and with great effect, where centralised light was not applicable, yet it might well be argued from *à priori* reasoning that a central light must be always more economical than a divided light. With regard to his own experiments, mentioned by Mr. Preece, he had carried them on since last year for the purpose of promoting the growth of plants by the electric arc, with the object, not so much of ripening strawberries and cucumbers sooner than his neighbours, but of ascertaining to what extent it was possible to produce rays capable of acting in substitution for solar rays, and also to what extent plants could be accustomed to bear this agency without intermission. He hoped to be able to lay further results before the scientific societies before long. One point of interest was the fact, that the steam-engine he employed to produce the electric light at night, afterwards yielded, through condensation of the waste steam, the heat for the green-houses, so that the electric light did not add materially to his coal consumption. Having to keep a fire under the boiler day and night, he thought it a good opportunity for utilising the steam power during the daytime, and he had done so by means of leading wires from the dynamo machine, to another similar machine at the farmstead working a chaff-cutter, to another for working a pumping engine nearly half a mile distant, and to a saw-bench in another direction; so that while doing its work near the green-houses, the engine was also cutting chaff and wood in one direction, and pumping water in another, and he hoped yet to make it available for ploughing the land also. Those facts showed that this mode of energy was extremely pliable, and could with great ease be made available at a distance. It is also important to remark that no other electrician was employed to keep the apparatus in order than the head gardener, without certainly any special training for this work.

Mr. Cromwell Varley, F.R.S., had not paid much attention latterly to the application of the electric light, and the very full remarks already made left him very little indeed to say. The reason why lights placed one after the other in one circuit were not so economical as the concentration of the entire power in one lamp placed at a great elevation, was that a considerable amount of power was required to heat the carbon sufficiently to make it glow, and that power was all dead loss. Every particle of power employed beyond that amount would heat the carbon more and more, and so a greater amount of heat would be obtained when the entire energy was concentrated in one lamp and one carbon, and a much greater incandescence than when so much power was spent in heating, at different parts, a great number of lamps. If it were possible to have stretched along a street one long conductor of fine wire of such a character that it would bear a very much greater heat than carbon, and could be made incandescent, of course the most uniform and perfect light would be obtained. Failing that, the next best thing was to get a comparative equality by using one light at a greater elevation. But in the City of London, where the atmosphere was loaded with particles of carbon which practically acted in such a way as to reduce the light from white to red, he was afraid that this mode of illumination would be no more successful than that of the sun on a foggy day.

Mr. Swan remarked that Mr. Preece had expressed some doubt as to the economy of light produced on the principle of the incandescence of a very thin conductor of carbon, apparently grounding his opinion upon Sir William Armstrong's calculations, but if the figures given by Sir W. Armstrong were worked out, they would show that the light obtained by means of the incandescent lamp could be divided to any extent into small portions, so that it might be conducted to any place where it was particularly wanted; and considering the advantage of distributed light, even taking the figures of Sir William Armstrong, it could be obtained with a sufficient degree of economy for practical purposes. And further, since Sir William Armstrong's experiments were made, a much greater degree of economy had been reached; he might say, without fear of contradiction, that at least twice the amount of light could be obtained by the same expenditure of power; it would be fairly within the mark to say that a light of 250 candles could now be obtained by an expenditure of one horse-power. Considering how very small a quantity of coal was required to develop the mechanical force — 2 lbs. would be sufficient—a very satisfactory return of distributed or divided light was afforded for it. Mr. Varley's illustration of the ideal mode of distributing the light along a street, namely, by having a very long wire made incandescent throughout its entire length, had suggested to his mind a very strong argument in favour of the divisibility of the electric light on the principle of incandescence, for it appeared almost self-evident that it would require no more mechanical power, and would, therefore, cost no more, to heat a wire extending the length of a street, than it would to heat the same wire if it was cut into a number of small pieces, separated by means of conductors of a size not to absorb any very large amount of the power. If Mr. Varley's straight wire were cut up into—say, 1,000 pieces, the same power would evidently be required to produce the light, and the economy of this, on the principle of incandescence, appeared to be, therefore, self-evident.

Sir Charles Bright called attention to the rapid advance made in electric lighting ever since the Paris Exhibition, and especially in the improvement of minor details in several of the dynamo-electric machines. Great improvements had also been made in the various kinds of arc and incandescent lights which had been introduced. Mr. Preece had calculated from the pound of coal, which was the common unit in calculations of power expenditure, but he hoped the day would come when calculations of the cost of the electric light would not be entirely based upon the consumption of any combustible material. When the system became better organised, the power necessary for the electric light might be derived from the watersheds of England, and so the cost of the light, at all events, to the towns within reach of such power, would be reduced very much in comparison with the cost of coal. The power of tides and of waterfalls might be hereafter accumulated for producing light for the whole country without the expenditure of one pound of coal, and not only for obtaining light during the night, but for many purposes of power for daily application.

Mr. Phillips (nephew of Mr. Brush) gave a brief account of the progress of the electric light in America. In the course of the last two years, about 6,000 electric lights had been introduced there, many of them for interior illumination in factories and depôts. The lighting of streets and open spaces in that way had also been very widely adopted. At Wabash, in the State of Indiana, the whole town was completely lighted by four lights, placed on the dome of the Court-house, and yielding a better illumination than could be obtained by more than five times the expenditure in gas. By that light the time could be distinguished upon a watch at half a mile distance; and within a radius of about 400 feet the smallest print used in newspapers could be distinctly read. Those four lights required but 7-horse power, and were maintained at a cost, including interest on the investment, of not more than 1,100 dollars, or a little over £200 per annum. In New York the light was to be extended over an area of a square mile, and

some 5,000 lights would be thereby introduced for street illumination. Montreal Docks were illuminated by 17 lights, run on a circuit of 17,000 feet of wire, and operated by one Brush dynamo-electric machine, absorbing probably about sixteen horse-power. Various factories in the United States were also lit in the same way; and as much as £400 or £500 had been invested by more than one firm in electric light apparatus. Upon that investment in one case about £300 per annum was being saved besides the cost of gas, so that in a little over a year, the cost of the apparatus would be paid for in the money saved, with a five times greater volume of light, and one which enabled all the colours of the goods to be distinguished, and prevented vitiation of the atmosphere in the work-rooms, which was, of course, a matter of very great consideration. Wabash contained 5,000 inhabitants, and extended over a radius of about five furlongs. To be sure, the light threw shadows of some density, but it was the experience of perfectly unprejudiced people that even in the shadows the light was considerable, and, in fact, much more than could be found half-way between two ordinary street gas-lamps.

Mr. Crompton, in reply to Mr. Preece's remark that a 6,000-candle power could, with difficulty, be realised by ordinary persons, suggested that an idea of it could be gathered from the fact that, by one of Dr. Siemens's or a Gramme 6,000 power candle-light, elevated 60 feet above the pavement, a *Globe* newspaper could be read comfortably, at a distance of 80 yards, and much more comfortably than under a gas-jet 15 feet above the pavement. Such lights were peculiarly valuable for illuminating docks and other large areas, as watchers and police could perceive any tampering with the goods within a radius of 400 feet. Probably the light was a hundred times more economical than gas, and, indeed, the number of gas-jets necessary to properly light up such vast areas could hardly be calculated. No doubt the lights on the Thames Embankment, which threw out highly refrangible rays, soon became invisible in fogs, but that was not the case with such lamps as were then burning in the room. Long after the highly refrangible rays given out by the arc itself ceased to pass through a fog, the rays proceeding from the incandescent carbon points would pierce to a considerable distance. From experiments, he had found that a powerful light, 80 feet high, would, even in a very dense fog, give a good light 60 or 80 yards round it.

Mr. Preece, in reply, said the difference between the Chairman and himself was but small, and one merely in words. Practically, he agreed with Dr. Siemens, that there were occasions when the problem regarding distributed light was solved, and where it was more economical and useful than centralised light. He might take exception to the arguments of Mr. Varley and Mr. Swan, as he he thought that it was not even theoretically possible to maintain a wire in a state of incandescence along a street. If it were practicable to do so, it would be also possible to divide the wire into a number of small lengths, but while it was found to be impossible in practice to keep 30 or 40 of these lights going, it would be equally impossible to maintain a wire in a state of incandescence that would illuminate a street 30 or 40 yards long. At present the idea of sub-dividing the light by breaking it up into small jets like gas was quite out of the question. Mr. Swan's success, between the two occasions he had visited London —not very far apart—in raising the illuminating power of his lamps from 140 to 250 candles, showed the advances he was making, and that he was working in the right direction. Mr. Phillips's account of what had been done in the town of Wabash and elsewhere in America, was extremely interesting, but the town was a small one, and it would be long before we should be able, with our present apparatus, to produce a light which, from the top of St. Paul's, would do much more than illuminate the immediate neighbourhood of the cathedral. He concluded by requesting the meeting to join in a cordial vote of thanks to Mr. Stevens, of Basingstoke, Mr. Hendricks, Mr. Joel, Mr. Swan, Mr. Crompton, Messrs. Siemens and Co., the British Electris Light Co., and several other gentlemen and companies who had kindly furnished lamps, diagrams, and apparatus for the purpose of the lecture.

The meeting was then adjourned.

During the first part of the meeting, the room was illuminated by a Siemens lamp and several Joel lamps. During the latter part it was lighted by a number of Swan lamps and a Brockie lamp. The current was supplied by a large and an ordinary-sized Gramme machine, and by a Bürgin machine. These machines were driven by the Robey 10 h.p. engine which has been used during the past fortnight for the illustrations for Professor Adams's lectures and Professor Perry's paper. The Society is indebted to the proprietors of the above lamps, machines, and engines, for the loan of them.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday, March 24, 1881; LATIMER CLARK, F.R.G.S., in the chair.

The paper read was on "The Future Development of Electrical Appliances," by Prof. JOHN PERRY. The paper will be printed in a future number of the *Journal*.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

APRIL 6.—"The Discrimination and Artistic Use of Precious Stones." By Professor A. H. CHURCH, F.C.S. Sir PHILIP CUNLIFFE-OWEN, K.C.M.G., C.B., C.I.E., will preside.

APRIL 27.—"Five Years' Experience of the Working of the Trade Marks' Registration Acts." By EDMUND JOHNSON.

MAY 4.—"Buying and Selling; its Nature and its Tools." By Professor BONAMY PRICE, M.A. Lord ALFRED S. CHURCHILL will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at eight o'clock:—

APRIL 5.—"Canada; the Old Colony and the New Dominion." By E. HEPPLE HALL. JOHN RAE, M.D., F.R.S., will preside.

MAY 10.—"Trade Relations between Great Britain and her Dependencies." By WILLIAM WESTGARTH.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings, at eight o'clock:—

APRIL 28.—"Impurities in Water, and their Influence upon its Domestic Utility." By G. STILLINGFLEET JOHNSON, F.C.S.

MAY 12.—"Recent Progress in the Manufacture and Applications of Steel." By Prof. A. K. HUNTINGTON.

MAY 26.—"Telegraphic Photography." By SHELFORD BIDWELL. Prof. W. G. ADAMS, F.R.S., will preside.

INDIAN SECTION.

Friday evenings, at eight o'clock:—

APRIL 29.—"On Indian Building Acts." By General MACLAGAN, R.E.

MAY 13.—"Burmah." By General Sir ARTHUR PHAYRE, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Four Lectures.

Syllabus of the Course.

Lecture I.—April 4.

Introduction. Early forms of twisted, plaited, and looped threads. Ornamental borders of Assyrian, Greek, Roman, and other costumes. Sumptuary laws. Venetian books of patterns for embroidery and lace. Flanders a centre of linen trade of Europe. Spanish and French importations of early lace. Effect of production of machine-made lace upon production of hand-made lace.

Lecture II.—April 11.

Needlework upon a material. Needlework upon separate threads. Venetian needle-point lace. Needle-point and tape lace. French needle-point lace-making centres. English and Flemish needle-point lace.

Lecture III.—May 2.

Fringes. Twisted thread-work in England in the 15th century. Early designs for plaited and twisted threads. Italian, Flemish, French, and English pillow lace. Laces of primitive design.

Lecture IV.—May 9.

Resumé as to styles of design in hand-made lace. Traditional patterns. Sketch of the development of inventions for knitting and weaving threads to imitate lace. Differences between machine and hand-made laces. Modern hand-made laces at Burano, Bruges, Honiton, &c.

This course will be illustrated by specimens of lace. Diagrams and photographs enlarged will be shown by means of the lantern and oxyhydrogen light.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures. May 16, 23, 30.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 4th ... **SOCIETY OF ARTS,** John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Alan S. Cole, "The Art of Lace-making." (Lecture I.)
Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m, Mr. T. Bell, "The Agricultural Returns for 1880, and their Teaching."
Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. Perry F. Nursey, "Illumination by Means of Compressed Gas."
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Prof. Balfour Stewart, "The Visible Universe."

Tuesday, April 5th ... **SOCIETY OF ARTS,** John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. E. Hepple Hall, "Canada; the Old Colony and the New Dominion."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. E. A. Schäfer, "The Blood." (Lecture XII.)
Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. B. Baker, "The Actual Lateral Pressure of Earthwork."
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Biblical Archæology, 9, Conduit-street, W., 8 p.m. 1. Mr. Ernest de Bunsen, "The Times of Israel's Servitude and Sojourning in Egypt." 2. Prof. Eb. Schrader, "Abydenus and the Book of Daniel."
Zoological, 11, Hanover-square, W., 8½ p.m.

Wednesday, April 6th ... **SOCIETY OF ARTS,** John-street, Adelphi, W.C., 8 p.m. Professor A. H. Church, "The Discrimination and Artistic Use of Precious Stones."
Geological, Burlington-house, W., 8 p.m. 1. Mr. Frank Rutley, "The Microscopic Structure of Devitrified Rocks from Bedgellert and Snowdon." 2. Mr. Frank Rutley, "The Microscopic Characters of the Vitreous Rocks of Montana, U.S." 3. Mr. T. Mellard Reade, "The Date of the Last Change of Level in Lancashire."
Entomological, 11, Chandos-street, W., 7 p.m.
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m. Mr. A. W. Gerrard, "'Wanika,' a new African Arrow-Poison, its Composition and Properties."
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lectures.) Dr. Southey, "Bright's Disease." (Lecture II.)
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. Thomas Morgan, "Remarks on the Roman Mosaics at Brading." 2. Mr. J. T. Irvine, "The Norman Cathedral of Bath, discovered during the repairs in 1869."
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.
Institution of Naval Architects (at the House of the Society of Arts), 12 noon. 1. Annual Report. 2. Election of Officers and Council. 3. Address by the President. 4. Mr. J. D'A. Samuda, "The *Almirante Brown*, Argentine cased Corvette, and the Effect of Steel Hulls and Steel-faced Armour on future War Ships." 5. Mr. W. Parker, "On Peculiarities of Behaviour of Steel used in Boilers, for the Russian Yacht *Livadia*." 6. Mr. J. R. Ravenhill, "On the increasing use of Steel for Shipbuilding and Marine Engineering."

Thursday, April 7th ... Institution of Naval Architects (at the House of the Society of Arts), 12 noon. 1. Mr. W. H. White, "The Stability of certain Merchant Ships." 2. Mr. James Hamilton, "Waves raised by Paddle Steamers, and their Positions relatively to the Wheels." 3. M. Marc. Berrier Fontaine, "The Use of Mild Steel for Shipbuilding in the French Dock-yards." 7 p.m. 1. Mr. W. Denny, "Local Education in Naval Architecture." 2. Mr. J. T. Milton, "Crank Shafts." 3. Mr. C. Stromeyer, "The Influence of the Cut Off and Length of Stroke, on the Working of Steam Engines."
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Prof. T. S. Cobbold, "The Parasites of Elephants." 2. Dr. Watt, "The Indian Species of Primula." 3. Mr. H. C. Sorby, "The Green Colouring of the Hair of Sloths." 4. Dr. W. A. Herdman, "Individual Variation in the Bronchial Sac of Ascidians."
Chemical, Burlington-house, W., 8 p.m.
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. The Second Conversazione.
South London Photographic (at the House of the Society of Arts), 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. H. H. Statham, "Ornament Historically and Critically Considered." (Lecture IV.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. B. Haughton, "Rainfall."
Archæological Institute, 16, New Burlington-street, W., 4 p.m.

Friday, April 8th ... Institution of Naval Architects (at the House of the Society of Arts), 12 noon. 1. Mr. W. H. White, "The Rolling of Sailing Ships." 2. Mr. R. E. Froude, "The Leading Phenomena of the Wave-making Resistance of Ships." 3. Mr. W. W. Rundell, "Freeboard and Displacement in Relation to Strains in Ships among Waves." 7 p.m. 1. Capt. E. Goulaeff, "The Imperial Russian Yacht *Livadia*." 2. Sir E. J. Reed, "The Injuries Sustained by the *Livadia* in the Bay of Biscay." 3. Mr. J. Biles, "Some Results Deduced from Curves of Resistance." 4. Mr. Charles Hall, "Notes on Screw Propulsion." 5. Mr. Colin Archer, "Shipbuilding a Thousand Years Ago."
Royal United Service Institution, Whitehall-yard, 3 p.m. Captain J. C. R. Colomb, "The Necessity for a Naval Intelligence Department."
Royal Institution, Albermarle-street, W., 9 p.m. Prof. Tyndall, "Conversion of Radiant Heat into Sound."
Astronomical, Burlington-house, W., 8 p.m.
Quekett Microscopical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.
New Shakspere, University College, W.C., 8 p.m. 1. Miss Constance O'Brien, "Shakspere's Old Men." 2. Miss Emma Phipson, "Was Shakespeare a Democrat?"
Royal College of Physicians, Pall-mall East, S.W., 5 p.m. (Lumleian Lectures.) Dr. Southey, "Bright's Disease." (Lecture III.)

Saturday, April 9th ... Ladies' Sanitary Association (at the House of the Society of Arts), 5½ p.m. Dr. B. W. Richardson, "Domestic Sanitation or Health at Home." (Lecture VIII.)
Physical, Science Schools, South Kensington, S.W., 3 p.m. Dr. J. H. Gladstone and Mr. Tribe, "Note on Thermal Electrolysis."
Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Rev. H. R. Haweis, "American Humorists." (Lecture IV.)
Geologists' Association, University College, W.C., 2½ p.m. Visit to British Museum (Natural History), South Kensington, under the direction of Dr. Henry Woodward.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,481. Vol. XXIX.

FRIDAY, APRIL 8, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The first lecture of the fourth course was delivered on Monday, 4th inst., by Alan S. Cole, on "The Art of Lace-making." Enlarged photographs of various kinds of lace alluded to in the lecture were shown by means of the lantern and oxy-hydrogen light.

The lectures will be printed in the *Journal* during the autumn recess.

DOMESTIC ECONOMY CONGRESS.

The third meeting of the General Committee was held at the Society of Arts on Wednesday, 6th inst., when the following ladies attended:—The Duchess of Leeds, the Countess of Airlie, Viscountess Strangford, Lady Arthur Russell, Dowager Lady Stanley of Alderley, Lady Jane Stewart, Lady Constance E. Kennedy, Lady Reay, Hon. Mrs. Oldfield, Lady Cole and Miss Cole, Lady Verney, Lady Clive Bayley, Miss Rose Adams, Mrs. Bartley, Mrs. Bidder, Mrs. Buckton, Mrs. Burke, Mrs. Cassels, Mrs. Cotton, Mrs. Grenfell, Miss Mary Gurney, Miss Frances Martin, Miss H. A. Martin, Miss A. Spottiswoode, and Miss R. Spottiswoode, with Miss Webb, Secretary of the Congress. Lord Alfred Churchill, Sir Henry Cole, K.C.B., Major-General Cotton, R.E. C.S.I., and the Rev. Newton Price, M.A., members of the Executive Committee, were also present.

HOUSE SANITATION.

The Council offer the following Medals for the best Sanitary Arrangements in Houses built in the Metropolis, the plans of such arrangements to be exhibited in the Society's Rooms, Adelphi, in June, 1881, and to be sent in on or before 12th May, 1881:—

1. One Silver Medal for the best sanitary arrangements, carried out and in satisfactory working, in a house let out in tenements to artisans, for which a weekly rental is paid.

2. One Silver Medal for the best sanitary arrangements, in actual working, in a house of the yearly rental of £40, or less, to about £200 in value.

3. One Silver Medal for the best sanitary arrangements, in actual satisfactory working, in a house of the yearly rental value of £200 and upwards, to any amount.

4. The houses must be open to the inspection of the Judges, who, in considering their award, will be guided by the suggestions of plans for main sewerage, drainage, and water supply, made under the Public Health Act, 1875. The houses must have been in actual occupation within the last three months, and a Certificate must be given by the occupiers, on a printed form, stating the satisfactory working of all the sanitary arrangements, such form to be obtained at the Society of Arts.

5. The houses may be old, fitted with modern sanitary arrangements, or may be new. They must be within the metropolitan area of the Board of Works.

6. The sanitary arrangements must include the conditions for good water supply, drainage, warming, and ventilation of the house, and precautions taken against frost.

7. The medals may be awarded to the occupiers of the houses, or the lessees, or the owners.

8. The plans must consist of a ground plan and sections, to the scale of not less than one inch to five feet; details of not less than one inch to the foot. The plans may be accompanied by specifications.

9. The names of the architects, surveyors, or sanitary engineers who directed the sanitary arrangements should be given, and Certificates will be awarded to those whose plans obtain the Medals.

PROCEEDINGS OF THE SOCIETY.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 6th, 1881; Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E., Member of the Council of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Beattie, William, London and South Western Railway Works, Nine-elms, S.W.
Cockburn, James, 11, Heathcote-street, Mecklenburgh-square, W.C.
Crossley, John Thomas, Q.C., 91, Cheyne-walk, S.W.; 4, New-square, W.C.; and Junior Athenæum Club, S.W.
Gibson, Joseph F., Clovelly, Woodchurch-road, West Hampstead, N.W.
Goodwin, Thomas, 12, Southwark-street, S.E.
Law, James, 544, Oxford-street, W.

Lovett, William John, Carver-street Works, Birmingham.
Lyell, Francis Horner, F.R.G.S., Nettlestone, Widmore, Bickley, Kent.
MacGregor, Alexander, M.A., 6, Charles-street, Berkeley-square, W.
Powell, Frederick, F.R.G.S., Bakewell, Derbyshire.
Pupikofer, Oscar, The College, Matlock, Derbyshire.
Stubbs, William Henry, 3, Winton-square, Stoke-on-Trent.

The following candidates were balloted for, and duly elected members of the Society:—

Atkinson, John, Tosti, Falsgrave, Scarborough.
Bacon, George Washington, F.R.G.S., 127, Strand, W.C.
Black, William, South Shields.
Lorimer, William, Messrs. Dübs and Co.. Glasgow.
Russell, William J., Ph.D., F.R.S., 34, Upper Hamilton-terrace, N.W.

The paper read was—

THE DISCRIMINATION AND ARTISTIC USE OF PRECIOUS STONES.

By Professor A. H. Church, F.C.S.

It was not without set purpose that I associated a scientific and an artistic conception in the title of this paper, for I am desirous of making a contribution, though it be but a small one, to the intelligent study and intelligent employment of precious stones. And I am convinced that some acquaintance with the less obvious qualities of well known gem-stones, and with the distinguishing characteristics of those species which remain practically unrecognised and unappreciated, will help forward the improvement of the jeweller's art in this country. Most admirable and pleasant colour-combinations are attainable by the aid of materials which, in many cases, are now by no means costly. Curious and delicate hues, of luminous quality, and in enduring substance, may be arranged and grouped in forms of endless beauty and variety. Neither silks nor paints, nor even enamels, can ever equal the colours of precious stones in durability, or in brilliancy and pulsating variety of hue. By pointing out some of the methods of discriminating one stone from another, I hope to be able to explain the modes which I shall cite or suggest, for their artistic employment. But I hope to do more than this. For when we know something about the intimate nature of any art-material, we begin to feel a more intelligent and a more lively interest in examples of good workmanship wrought in the substance in question. Every *connoisseur* or collector of artistic objects must have shared in experiences of this kind. He may have been once quite dead to the peculiar merits of certain works—say, in bronze, not even glancing at any specimens falling in his way. Then some casual circumstance, perhaps an exciting contest for a fine piece of work at a sale between two enthusiastic collectors, or perhaps the gift of a choice specimen, may have drawn attention, I will not say to the merits of such specimens, but at least to the esteem in which they may be held. Curiosity—it may be an intelligent curiosity—is excited. Investigation, more or less searching, follows. The hardness of the metal, its *provenance*, its designer, its age, the mode of manufacture, whether by casting or hammering; the manner of decoration, whether by chasing, engraving, or inlaying; the colour and texture of the surface, the presence or absence of *patina*, and not a few other points of interest, constitute the materials of complex study. Study provokes observation, and observation study, so that before long the neglected group of artistic bronzes exerts a kind of fascination upon the new votary. If his knowledge be superficial and inaccurate, or if he be merely an amateur or collector just because it is a fashionable pursuit to gather together or to admire certain classes of artistic objects, well, then, he does not really know what and why he admires. Forgeries delight him just as much as genuine works, so long as he is not sure that they are forgeries; but he has not sufficient patience for the mastery of, or sufficient insight into, the characteristics of true productions, to discriminate them from those that are false. It often happens thus with the amateur of precious stones. He knows nothing of the optical elements, say, of surface lustre, and the pleochroism which go to make up the *tout ensemble* of any particular gem, and is quite satisfied with a well-cut bit of paste, or a cleverly contrived doublet. No doubt, in some cases, even an educated keenness of vision does not suffice to distinguish the true stone from the false, although the durability of the genuine specimens will ultimately prove their superiority. But it is not difficult to learn to appreciate the peculiar and essential characters of the majority of the species of precious stones. What I wish to compass to-night, has, then, not merely relation to the artistic use and arrangement of gems, but also to the appreciation of their inherent characteristics, so far at least as these affect their appearance. I want to sketch these characteristics, and then to compose them into pictures. For this purpose I have set down, in some sort of order, the most valuable optical distinctions belonging to precious stones, arranging these under the general heads of "Surface" and "Substance":—

1. Plane	Form	Surface.
2. Curved	Form	Surface.
3. Metallic	Lustre	Surface.
4. Adamantine	Lustre	Surface.
5. Resinous	Lustre	Surface.
6. Vitreous	Lustre	Surface.
7. Waxy	Lustre	Surface.
8. Pearly	Lustre	Surface.
9. Silky	Lustre	Surface.
10. Transparent	Light	Substance.
11. Translucent	Light	Substance.
12. Opalescent	Light	Substance.
13. Chatoyant	Light	Substance.
14. Opaque	Light	Substance.
15. Prismatic	Colour	Substance.
16. Monochroic	Colour	Substance.
17. Pleochroic	Colour	Substance.
18. Fluorescent	Colour	Substance.

I will now proceed to give some examples of the use of such a tabular statement as this. Referring to the shape of stones, we note that their boundaries are either plane or curved. Now, if we want to use curved surfaces, like those of pearls, we shall find that it will not answer to associate

with them other curved surfaces, like those of the *en cabochon* moonstone; and especially is this the case where the size of the stone as well as the character of the curved surface is nearly identical; but a happier result will be attained by combining a step-cut stone with one having a curved surface. Once more, citing an example from the series of adjectives expressing qualities of surface, it will be found that gems having an adamantine lustre assort better with those which present the less brilliant surface known as waxy, than they do with those which show a nearer approach to the adamantine surface, and which are called resinous. The diamond and the jargoon do not improve or bring out each other's qualities, for they have too many points in common; but the diamond accords well with the pearl, and the jargoon with the turquoise, that is, the adamantine with the pearly, and the resinous with the waxy. Looking, now, into the substance of stones, rather than on their surface, their relations to the transmission of colourless light furnish many illustrations of wise and unwise, or effective and defective combinations. For example, chatoyant stones, like cat's-eyes, do not associate well with translucent stones like the chrysoprase and the chalcedony—the translucency of the latter confuses, because it resembles too closely the chatoyancy of the former. But transparent stones accord well with all those which interrupt the passage of light by such internal reflections. The diamond, on this account, combines admirably with the cat's-eye and the pearl, but it affords too strong a contrast, especially when of large size, with the turquoise, to associate pleasantly with this nearly opaque stone. From amongst the qualities pertaining to the colour of stones, examples of the utility of my table may be cited. When a stone has much "fire" in it—that is, when its refractive and dispersive actions upon light are high—and it shows prismatic hues, then it looks best if associated with gems in which this property is less developed. Again, monochroic stones, which in all directions transmit beams of the same colour, should be associated with pleochroic stones which exhibit two or more hues, while the latter should not be mixed together.

It may be useful, as an introduction to the study of individual precious stones, to say a few words concerning the physical experiments by aid of which qualities can be best ascertained and discriminated, where, in fact, we cannot employ or wholly trust to the eye. The materials required for such experiments are very simple, and include—

a. A set of mineral fragments — diamond, sapphire, spinel, chrysoberyl, topaz, garnet, and quartz—to be used as tests for relative hardness.

b. A small pocket spectroscope, by which absorption-bands, as those of the garnet and jargoon, may be detected.

c. A dichroiscope, or double image prism, suitably mounted, by which the pleochroism, or difference of colour in the light transmitting in different directions in the same stone, may be ascertained.

d. Liquids or easily fusible solids, of high specific gravity, from 2·3 upwards, by means of which the detection of different densities in doubtful specimens may be easily accomplished.

The applications of this critical apparatus to the discrimination of certain precious stones will be mentioned further on, in connection with particular species. But a few lists or tables of the hardness, pleochroism, and specific gravity of some of the more interesting and valuable of precious stones will be useful here. Such tables are more convenient for practical and ready use when arranged in a kind of progressive order, such as I have adopted. The hardness assigned to the different species, or varieties, must be taken as average or approximate only. The terms used to designate the differing colours of the oppositely polarised beams in dichroic stones, are the best I could select, but refer merely to the specimens examined. The table of specific gravities contains a selection from about 200 specific gravities, taken by myself with unusual precautions.

TABLE OF HARDNESS.

Diamond	10·0	Iolite	7·3
Sapphire	9·0	Cinnamon stone	7·0
Ruby	8·8	Jadeite	7·0
Chrysoberyl	8·5	Amethyst	7·0
Spinel	8·0	Jade	6·5
Topaz	8·0	Peridot	6·3
Aquamarine	8·0	Moonstone	6·3
Emerald	7·8	Green garnet	6·0
Zircon	7·8	Turquoise	6·0
Tourmaline	7·5	Opal	6·0
Phenakite	7·5	Lapis-lazuli	5·0
Almandine	7·3		

TABLE OF PLEOCHROIC STONES.

Name of Stone.	Twin Colours.	
Sapphire, blue	Blue	Greenish straw.
Ruby, red	Aurora red	Carmine red.
Tourmaline, red	Salmon	Rose pink.
,, brownish red	Umber brown	Columbine red.
,, brown	Greenish yellow	Orange brown.
,, green	Pistachio green	Bluish green.
Emerald, green	Yellowish green	Bluish green.
Topaz, sherry	Rose pink	Straw yellow.
Peridot, pistachio	Sea green	Brown yellow.
Aquamarine, sea green	Grey blue	Straw white.
Beryl, pale blue	Azure	Sea green.
Chrysoberyl, yellow	Greenish yellow	Golden brown.
Iolite, lavender	Indigo blue	Pale buff.
Amethyst, purple	Bluish purple	Reddish purple.
Tourmaline, blue	Indigo blue	Greenish grey.

TABLE OF SPECIFIC GRAVITIES.

Zircon :—		Spinel :—	
Jacinth (Espaly)	4·863	Indigo	3·715
Columbine red	4·705	Indigo	3·675
Green	4·691	Puce	3·637
Brown	4·696	Rose	3·631
Red brown	4·651	Puce	3·592
Brown yellow	4·620	Aurora red	3·590
Yellow	4·600	Olivine :—	
Orange yellow	4·362	Peridot	3·389
Dull green	4·020	Topaz :—	
Garnet :—		White	3·597
Red	4·059	White	3·571
Yellow green	3·854	Wine yellow	3·540
Emerald green	3·849	Tourmaline :—	
Pistachio green	3·848	Green	3·154
Cinnamon stone	3·666	Black	3·124
Cinnamon stone	3·642	Red	3·044
Sapphire :—		Red brown	3·009
Yellow	4·030	Beryl :—	
Yellow	4·006	Emerald	2·704
Blue and white	3·979	Aquamarine	2·702
Chrysoberyl :—		Blue	2·701
Golden yellow	3·840	Yellow	2·697
Yellow	3·760	Brown yellow	2·690
Brown yellow	3·734		

Quartz :—		Very dark Amethyst	2·662
Milky	2·642	Adularia :—	
Pure Rock Crystal	2·650	Moonstone	2·585
Brown Cairngorm	2·656		
Amethyst	2·659		

It has been no easy matter to decide upon the order in which the several most important precious stones should be discussed. In a chemical paper, a classification in accordance with composition would be absolutely right; while such physical properties as hardness and specific gravity might be made prominent features in the arrangement of the species in a physical paper. But as the ornamental or artistic employment of precious stones conveys primarily, if not wholly and ultimately, an appeal to the eye, it is clear that such optical properties as can be comprised in the terms colour, lustre, and light should afford the bases of our classification. On the whole, the prominent feature of precious stones is their colour, and the easiest way of considering their colour is to adopt the order of succession of the colours in the ordinary rainbow or prismatic spectrum, beginning with the white light from which they all spring.

White Stones.—The diamond naturally takes the first position if we consider its hardness, its remarkable composition, and its strong refraction and dispersion of light. Its properties, so far as they appeal to the eye, differ much from those belonging to the majority of other stones, and it forms, partly in consequence of this peculiarity, as good a border or setting to other jewels as a gold frame does to a picture. Of course much depends upon the quality of the diamond, and much upon the shape which is given to it by the lapidary. The flat plates of *lasque* diamonds, and, in less degree, the step-cut stones with broad tables, exhibit the unique and splendent lustre which is peculiar to the polished surface of this stone; these forms also permit the transparency and the total internal reflection of light to be well seen. Even the form of the diamond crystal, the regular octohedron, when its surfaces are really planes, well exhibits the transparency and reflection of the stone.

This seems the place to raise a protest, which, indeed, I have done on many previous occasions, against the ignorance and narrowness which would condemn diamonds and all other stones, irrespective of all the optical differences which they present, to be cut *en cabochon*, or tallow-topped, that is, with a convex rounded surface. A certain clique of artists and amateur writers on art insist upon all stones being cut in this way, which, in the majority of cases, is fatal to the development of those optical qualities upon which the beauty of precious stones mainly depends. Indeed, the facetting of the great majority of transparent stones is not only a necessary operation, but it should be done in strict accordance with certain rules of proportion, which may be deduced from the optical constants of the species of stone operated upon. But with pale and defective specimens, the *cabochon* form is often found more suitable than the rose, or brilliant, or stepcut; and it is the only method of showing to advantage the peculiar beauties of a large number of translucent, chatoyant, or opaque stones, like the chrysoprase, the opal, the moonstone, and the cat's-eye.

Next to the diamond, we may place the colourless zircon or jargoon, then the phenakite, then the white sapphire, the white topaz, and the white beryl. Rock crystal will come below these in point of beauty and brilliancy. The colourless zircon (of which a fine specimen set in a ring may be seen in the British Museum Mineral Gallery, now at South Kensington) approaches very near in prismatic brilliancy to a diamond; so, at night especially, does the rare and curious mineral phenakite. There is, however, always a sort of difficulty in finding an appropriate use for colourless, yet lustrous, stones in any article of jewellery intended for personal adornment. The more lustrous and prismatic they are—the more they resemble the diamond in fact—the less available are they for the usual purpose to which gems are put. Still, there are peculiar qualities in these stones which need not be lost to artistic employment, if the white stones in question were judiciously associated with materials which would prevent their being mistaken for diamonds. A white diamond would rarely or never be bordered by green tourmalines, but these stones would form an agreeable combination with a white zircon, a phenakite, or a white topaz. In the sapphire there is usually a faint suspicion of milkiness, and in the white beryl a cool greyish tint, which prevent these stones from resembling the diamond so closely as to be taken for imitations of that gem. But many of these colourless stones, notably the topaz and rock-crystal, in all probability are most appropriately used when set as bosses in vessels, and other large pieces of metal-work, or employed in the form of plaques for engraving or etching. It is scarcely necessary to justify such uses of these minerals, and this is not the place to enter upon the question, particularly as it is only by a rather wide use of the term precious that I am able to include these materials, and some others of which I shall have to speak presently, amongst precious stones. Of two other white materials employed in jewellery, the moonstone and the pearl, a few words may be introduced here. The moonstone forms an excellent substitute in many combinations for the pearl, but it does not associate quite so well as the latter with the diamond. With deep-coloured amethysts, spinels, and tourmalines, few colourless gems look more refined than the moonstone. But these stones, which fetch a shilling or so a piece only, should always be accurately re-cut and highly re-polished before being used. Their forms are too irregluar, and their surfaces too imperfect, as imported from Ceylon, to show off their moonlight sheen with half its intensity, unless they are passed again under a careful lapidary's hands. The improvement thus effected is marvellous. The value of the pearl, whether its "orient" be luminous with prismatic hues, or whether it be a warm, soft white merely, is too well known to be more than named in this connection. But I may be permitted to say one word in deprecation of the extravagant expenditure of time, of ingenuity, and of costly materials, which the attempt to convert large irregular pearls into structures resembling figures has so often caused. The result is nearly always most unhappy.

Red Stones.—The ruby may fitly be considered before other coloured stones. It, with the sapphire, and all the transparent varieties of

corundum, ranks next to the diamond in hardness. It is, moreover, a stone of great beauty. Probably the experts in jewels are right in assigning the highest value to those rubies which possess a "pigeon's blood" colour—this is the orthodox hue. But the paler colours, and those which verge upon pink and crimson, and even violet, are capable of being so treated by means of association with white and black enamel, or with dark stones, like olive-green tourmalines, as to lend themselves to the production of very beautiful decorative effects. The great mistake commonly made in the treatment of the paler rubies, lies in the attempt to treat them in the same way as the deeper-coloured stones.

It is difficult to describe the peculiar colour-quality of the ruby in words. In fact, our nomenclature of colours is neither ample nor accurate. Our appreciation of delicate differences between colours is growing, but the language by which we endeavour to describe the hues which we have learned to appreciate is either stationary, or else receives additions from time to time of unsatisfactory words, derived from the caprices of French fashions. The time has really arrived when a standard series of hues of all sorts should be constructed and appropriately named; but, in the case of the ruby, the question of pleochroism comes in, and renders the difficulty of describing the colour-quality of this stone greater. There is also some prismatic "fire" in the stone, and much internal reflection of light, while its surface lustre lies between resinous and vitreous. These four properties give to the red of the ruby a peculiar richness, which the two other species of precious stones—the spinel and the garnet—which come nearest to it in colour, do not equally possess. The two reds which make up the colour transmitted by the ruby do not differ much, but yet they help to impart, to a properly cut stone, a delicate variation of hue which is not present in any other red stone, nor in any imitative substance. The dichroiscope, consequently, never fails to discriminate between a ruby on the one hand and a spinal or a garnet on the other. The two latter stones are, of course, softer than the ruby, and the former is always lighter, that is, of less specific gravity. For the ruby, and the whole of the corundum family of stones, have the specific gravity of 4, and a hardness which is nearly, and in some cases quite 9, on the mineralogical scale.

One of the happiest uses of the ruby is in the form of an inlay, in certain gold vessels of Indian origin. The external surface of these vessels is covered with a system of interlacing ridges and furrows. The rubies, generally small, oval, and cut *en cabochon*, are set along the furrows. Thus they are much protected from the chance of dislodgement, while the effect they produce, of a rich deep crimson groundwork over which a gold netting has been thrown, is in perfect harmony with the materials and their workmanship. For, naturally, the metal gold, when pure, or nearly pure, throws a ruddy tint when light is reflected from surface to surface; witness the interior of gilt vessels. The same thing occurs in the golden furrows of which we have spoken, where the rubies seem to rest in a golden sheen, of a hue in which the yellow, and orange, and red elements, now one and now another, appear to prevail. The gold should not be burnished where much contrast between the metallic surfaces and the rubies is desired, but the stones themselves should be as brightly polished as possible, in order not only to develop the full beauty and variety of their colour, but also the very considerable surface lustre which the ruby possesses. There is another kind of Indian jewellers' work to which most of the remarks I have just made apply. A perforated plate or disc of delicate arabesque or radiated work is found decorated with ruby beads, round or oval, attached to the circumference of the ornament, or else introduced into its midst in concentric circles. Here dull, dead or "matt" gold is particularly appropriate, as affording a pleasant contrast to the rich, smooth, and soft transparency of the rubies, which, from the manner of their mounting, may be looked through. The refinement of the slender gold-work, which, in this class of jewellery, approaches the delicacy of filagree, sets off by its minuteness of detail the simpler and bolder forms of the plain, smooth, rounded stones, which give it colour and warmth. I must dwell for a moment or two upon another Eastern method of dealing with the ruby. I refer to the use of this stone as an inlay or onlay—that is, an incrustation—upon jade, both white and green. It is not so much here a beautiful contrast of colour that is attained, although the greenish grey or olive green of the jade, enhances the redness of the ruby; but it is a contrast of textures, a contrast of surfaces, a contrast of translucencies. You see but a little way into the jade, though it is illuminated by a soft diffused light; but you see through the clear deep-toned rubies, with their flashing beams of crimson.

Now compare with these examples of the artistic employment of the ruby, the ordinary mode in which this stone is set by English jewellers. Look at the half-hoop ruby ring, with five rubies well matched in colour, and graduated exactly in size, set close together in a regular row. You see, perhaps, a little speck of gold appearing here and there at each end of each stone, but nothing is made of these pieces of gold. You accept them because you know they are necessary to hold the stones in their places, but you find neither invention nor beauty in these little bits of gold claws. In fact, they are frequently prepared by the gross, ready for the mounting of any stones, provided the shape of the latter be suitable. Rubies, sapphires, diamonds, garnets, and emeralds are all set in the same way, not an attempt being made to adapt the amount of gold surface or its form to the specific nature of each gem. But why should not some variety and some appropriateness of mounting be secured for all stones? How exquisite, and yet how strong, were the gold and enamel settings of precious stones in the Cinquecento time in Italy. Let those patrons who desire the rather barbaric splendour of masses of rubies gratify their taste by means of jewels in which the setting is not seen at all. But surely a fine stone is worthy of a fine and originally designed setting—proportioning the latter in form, in amount of work and surface, and also in colour, whether red, or green, or yellow gold, or enamel, to the shape and the hue of the stone to be set. And even small stones become quite beautiful, when arranged with taste and judgment, in accordance with the conditions I have named, and with the

further condition as to collocation of individual stones in accordance with their size and shape. In pendants, and necklets, and lockets, and brooches there is room for the expression of some definite and intelligible design. The mere alternation of rubies with diamonds in rows or chequer work may, in some instances, achieve all that is needed. But a design of more definite form may often be preferable, especially where the stones at one's disposal are of differing colours and sizes. Then one may construct a suitable bit of leafage or flowerage, duly conventionalised, in accordance with the nature of the available materials, into forms of more or less geometrical severity. It should be noted that moonstones, and white sapphires, in which there often lurks a faint opalescence, accord well with rubies; but it must be kept in mind that the size of the colourless stones which are to be associated with rubies in such designs as those which I have named, is a matter of much moment. It is a mistake to attempt to match the colourless and the coloured stones in respect of size, and generally of shape also. One should be smaller than the other. Large rubies with small moonstones, or small rubies with large moonstones, and similarly, square stones with round, and oblong stones with round, generally produce happier effects than square with square, and oblong with oblong. Pearls accord with rubies, not only by reason of their colour relations, but also on account of their shape. In the case of rubies cut *en cabochon*, brilliant-cut or square step-cut diamonds will be found to yield very satisfactory combinations. A border of small brilliants or roses is a usual and a useful mode of setting off the qualities of a ruby. The colour of a pale stone is heightened by contrast with the colourlessness of the diamonds; the richness of a rich stone is enriched, and a small stone, if surrounded by stones still smaller, becomes magnified in proportion.

Next to the ruby, amongst the red stones, comes the spinel or balais ruby, an entirely different mineral species, without any pleochroism, and inferior in hardness to the true ruby. The scarlet, aurora red, and flame-coloured spinels are the most beautiful; those which verge upon crimson, purple, and violet, looking dull and black at night, but showing very delicate and often rare hues by day. Red spinels accord well with small brilliants, or with larger pearls or moonstones. A fine aurora-red spinel looks well when surrounded with delicate foliage of white, orange, and black enamels. Step-cutting, similar to that employed for emeralds, accords best with the optical qualities of this stone. A biconvex lenticular form may be so adapted to this stone, as to throw a good deal of soft and rich colour into a specimen which would otherwise have had little beauty to recommend it. What richness of hue the finer examples of red spinel may show is to be studied in two specimens in the Townshend collection, South Kensington Museum, Nos. 1,326 and 1,327.

From spinels the passage to garnets is easy. But it is not really difficult to discriminate between the two species, even when the colours seem the same. If you have a ruby, a spinel, and a garnet together, the first will scratch the second and the second the third. The ruby will show two colours in the dichroiscope, the spinel and the garnet only one. The spinel will exhibit no black bands like those belonging to the red garnet, when viewed with the spectroscope. And there is a blacknesss, due to much absorption of light, in many of the facets of a garnet, as seen from the "table" of the stone, which will not be observed in the spinel. The garnet, unless of remarkable size or quality, will hardly be deemed worthy of being mounted in the same costly way as the ruby or the red spinel, but it may be said that the same general treatment suits all these red stones. Yet there are two ways in which garnets have, for long and in many places, been treated, to which I may legitimately refer here. The plates of garnet so largely found in Anglo-Saxon and Celtic jewels have remained, in the majority of cases, intact to the present day. They afford, in their breadths of soft, rich colour, a pleasant contrast to the minute filagree, granulated, and enamel work, with which they are generally associated. The other employment of the red garnet (and it may be traced back to a far earlier date than that I have just cited) is as a carbuncle—not necessarily foiled at the back. Cut *en cabochon*, slightly hollowed behind, and laid on a plain gold surface, the light, as of a glowing coal, quivers in the midst of a good stone. There is a lovely disc of antique gold set with five carbuncles in the Gold Ornaments Room at the British Museum. There is a round carbuncle boss in the centre; then four long pointed arms, like much elongated pears, radiate from this centre, alternately with a somewhat similar series of *repoussé* arms, beaten up from the disc of gold, and bordered with nurled wires onlaid. There is not much work in the piece; the intrinsic value of gold and garnets is quite small, but the effect is delightful; simple, yet rich; solid, yet elegant. Can the same praise be honestly given to modern garnet-work? Can we feel a genuine satisfaction either in the design, the execution, or the effect of a compound big carbuncle of eight lobes, with a six-rayed star rivetted into the midst of it, the aforesaid star being of hard, poor, glittering, much alloyed gold, and containing a number of irregular fragments of defective diamonds? The star soon gets loose, and, later on, the diamonds begin dropping out. But I will not pursue the history of the piece any farther, and I will refrain from calling your attention to other obnoxious modes of using the carbuncles say, in a ring with a sham gold knot on either side.

Amongst orange and yellow stones I would, unhesitatingly, assign the first place to the yellow zircon—a stone which is sometimes found of a hue which may be aptly described as that of transparent gold. Next to this comes the cinnamon stone, or essonite; and then we may place the rich sherry-coloured Brazilian topaz—that kind which yields, when heated, the finest rose-pink stones. Yellow sapphires take an almost equal rank with the best topazes, and then the chrysoberyl follows, and, at some distance, the yellow beryl. Few colour combinations have been attempted with these yellow stones; puce-coloured spinels I have found to associate with the yellow sapphire very happily, but there are some enamels which answer equally well. Generally, a design of pale blueish-grey enamel, with minor details wrought in buff and white, developes the richness of gold-coloured stones.

There are two green stones about which something ought to be said—the emerald and the tourmaline. I do not sympathise with those persons who regard the green of the emerald as vulgar. It is too easy to construct a vulgar, coarse ornament out of emeralds, even if they be of fine quality; so much I will allow. But the emerald, step-cut, and judiciously and quietly mounted, possesses a rich and refreshing colour, just sufficiently dichroic to show passages of bluish-green with the green. Green tourmalines are much more markedly dichroic, and it is much to be regretted that, with rare exceptions, the patrons of the jewellers' art still remain ignorant, not only of the peculiarly rich and varied qualities of the colour of the tourmaline, but even of the existence of this gem-stone. With moonstones, or with grey and white enamel, long prismatic tourmalines, carefully cut, afford a delightful colour-combination peculiarly fitted for larger pieces of personal adornment, such as pendants and brooches. The so-called green garnets of the Urals, especially those which are of an olive or pistachio green, are lustrous and fiery stones, but their softness precludes their use in rings. The same objection holds good with regard to the lovely stone, the peridot, but this species occurs frequently of large size, and so is well adapted for employment in jewels not subject to much attrition. It is a dichroic stone; it accords well with small puce, violet, or indigo spinels, also with black and white enamel.

Passing over, for lack of time, the varieties of beryl known as aquamarine, the green and blue beryl, the blue topaz, and the green sapphire, I must linger for a few moments over the sapphire. The dichroism of this stone, strong though it is, does not appear much in the cut specimens we usually see. But I do not doubt that the twin beams of diversely-coloured light which this stone transmits, one azure blue, the other greenish straw, contribute to produce the peculiarly rich quality of its velvety softness. There is a glittering coldness in all the imitations of the sapphire—the *timbre* of their colour, if I may borrow a word from music, is harsh and unsatisfactory. So a recent imitation, a kind of lime-spinel made artificially, exhibits apparently the right colour, but it is flat and uninteresting. To my eye, the difference between a true sapphire and a false one is the analogue of the difference between a piece of leafage in wrought iron, and the same piece in cast iron. As to the arrangement of the sapphire in jewellery, so much depends upon its depth of colour and its precise hue, that a general rule would be fallacious. Unless it be pale, when certain green tourmalines go well with it, the sapphire may be most safely associated with pearls, diamonds, moonstones, or white topazes the cutting and size of the stones being carefully studied.

I wish I had time to say something about the amethyst, both the violet quartz and the harder and infinitely rarer violet sapphire. But if I have been compelled to omit such observations, and many other things which I would gladly have included, I may, perhaps, entertain a reasonable hope that what I have found time and opportunity to introduce may stimulate the production, and the appreciation also, of new and choice colour-combinations of precious stones, and may tend to a more lively and intelligent interest in those little-known and little-prized species, the jargoon, the tourmaline, and the spinel.

Before concluding, I may be permitted to direct your attention to two matters of considerable importance in connection with this subject, if our interest is to be sustained, enlarged, and educated. I refer to collections of specimens of precious stones, and to books on the subject. You must go to public museums if you are to see a jargoon or a tourmaline. With a very few exceptions, the largest and most noted London jewellers could not produce a single fine specimen of these curious stones, nor identify them if they were shown to them. I had five good stones mounted by a well-known goldsmith a few years ago, and he misnamed every one of them in the bill. Signor Giuliano, of 115, Piccadilly, is, indeed, the only artist-jeweller whom I know to have made a speciality of the judicious employment of these out-of-way stones.

I commend to your notice three collections of precious stones. In the Museum of Practical Geology, Jermyn-street, there is a small series amongst which the jargoons (especially a green one) are particularly fine. In the Mineral Department of the British Museum, now at South Kensington, a most complete series of every kind of precious stone, distributed, however, in many cases according to their mineralogical position, will be found. And the South Kensington Museum itself owns a fine series of mounted precious stones, 178 in number, the bequest of the late Rev. Chauncey Hare Townshend. Unfortunately, the official catalogue (1877) of the Townshend collection contains more than twenty incorrect or doubtful attributions. But you will learn much from this series, if you will bear in mind the corrections which I made in this list, in a paper published in the *Spectator*, on July 9th, 1870, which I repeated in the *Quarterly Journal of Science* for January, 1871, and which were adopted by Mr. Hodder M. Westropp, in his compilation, published in 1874, and entitled a "Manual of Precious Stones." I will just give you a single instance of how misleading are the names affixed to some of the Townshend gems. On page 17 of the catalogue (last edition), Nos. 1306 and 1307, and those only, are described as hyacinths, jacinths, or zircons. Both are garnets, and so the Townshend collection would appear to include no representative of this interesting species. But this is not so. For Nos. 1281 and 1282, called garnets, are really zircons; so, probably, is No. 1305, which figures as a chrysolite; and there is a fourth characteristic specimen, No. 1322, labelled tourmaline. But if you make these corrections, and 14 others (Nos. 1184, 1188, 1192, 1194, 1195, 1277, 1290, 1297, 1298, 1299, 1304, 1309, 1312, and 1318), you may study the remainder of these specimens with satisfaction and confidence. In a neigbouring case to the Townshend series there are some interesting specimens lent by the Right Hon. A. J. Beresford Hope. But here note that Nos. 60 and 61 are not jacinths, but garnets; that 42 is not a sapphire, but a bit of blue glass worth 4d. or 6d.; that 53 is not an emerald, but a bit of green glass, though next to it is a veritable emerald, or rather two, carved into a vinaigrette; that No. 110, called an aquamarine, is actually a sapphire, and that No. 113 is a tourmaline, not an aquamarine.

Of the many books written of late about precious stones, few have any claims to scientific exactness, or afford any satisfactory indication as to the artistic arrangement and use of precious stones. Many interesting facts and fancies about particular stones, and about their commercial aspects, are given in Mr. H. Emanuel's "Diamonds and Precious Stones" (1865); and more particularly in Mr. E. W. Streeter's "Precious Stones and Gems" (1877). But the little volume by M. Louis Dieulafait, entitled "Diamants et Pierres Précieuses" (1871), which has been translated into English, commends itself on many accounts as the neatest, cheapest, and most trustworthy manual of the subject which has yet appeared. I venture to refer also to my own papers previously named, to one in vol. i. of the *Magazine of Art*, and to a paper in the *Proceedings of the Geologists' Association*, vol. v., No. 7.

In conclusion, I must ask you to pardon the omissions, and they are many, in this paper, in which a large subject had to be handled in a short time. And I must ask you, further, to pardon the imperfect and inadequate manner in which I have attempted to express the results of my own thought and work, in those sections of the subject upon which I have found time to say something. If my paper serves in any way to stimulate and direct thought upon the artistic employment of precious stones, such a result will be as much as I could have hoped for, and more than I have warrant for expecting.

DISCUSSION.

The Chairman said they must all be very grateful to Professor Church for the very interesting paper he had given them, and he personally felt specially grateful to him for having exposed the shortcomings of the South Kensington Museum. Nothing was so healthy to any public institution as criticism, and he should not only take advantage of the criticisms he had heard, but should try to get from Professor Church, who seemed to be an authority on a large number of varied subjects, a popular handbook on this subject of precious stones. He had followed the paper with great interest, and he hoped there were some gentlemen present who would be prepared to discuss it.

Mr. Edmunds said he must confess that his business as a jeweller was carried on more by rule of thumb than on scientific principles; he was guided principally by what would sell, and therefore he could not pretend to instruct the meeting in any way. He cordially agreed with what the Chairman had said as to the value of the paper, and should be very much pleased to see a taste for precious stones cultivated. At present the jewellery business was guided mainly by intrinsic value, and there was not nearly so much taste and skill exercised in mounting as might be seen on the Continent. There was room for a great deal of improvement in this direction, and he hoped that this paper might have some good effect in directing more attention to this subject.

Mr. Liggins, after complimenting Professor Church on the paper, said his opinion was that when they had anything so magnificent as a diamond, ruby, or emerald, it was the duty of the manufacturer to assist, by a nice combination of colour and art in the setting to improve the appearance of those splendid gems. They were also indebted to Professor Church for information as to how to distinguish real from spurious gems. He did not know that he was ever more pleased than on one occasion last year, when he heard a paper at the Royal Society on the manufacture of diamonds. His satisfaction was not at the fact that diamonds had been made by man, because he thought that would be a most disastrous application of science, but it was an extraordinary and beautiful fact that the ingenuity of the chemist could produce what he believed was generally considered to be the purest thing in nature, the pure carbon of the diamond. At the same time, he believed there was very little prospect of the manufacture being carried out, except as a scientific experiment; that there was, in fact, no chance of getting manufactured diamonds to supplant the work of Nature. In his opinion, the jeweller's art had very much advanced within the last few years, especially since the Exhibition of 1851. There had been a vast improvement in the setting of gems, and further advances might be looked for from that paper, and a study of the collections to which reference had been made.

Mr. James Price said he was sure Professor Church would pardon him if he ventured mildly to criticise one or two points in the paper. He quite agreed with him that a great deal depended on the harmony with which colours were blended, in the production of works of art in precious stones, and also in the form given to them; but with regard to the condemnation which had been passed on the practice of cutting stones *en cabochon*, there was this to be said, in the case of rubies, emeralds, and other stones, if they were sufficiently pure to show that brilliancy for which they were so much admired, and in which their principal value consisted, it would be an immense sacrifice to cut them in this way; but when they were not of first-rate quality, it was a great advantage to cut them *en cabochon*, because it hid to a great extent the flaws and faults which the stone contained. That was the principal reason for adopting this form; and another reason was that they sold better, and were more in demand than facetted stones of the same class. Of course, the sale of stones, and the profit to be made out of them, would always influence those who dealt in them, and there was a much greater demand for *cabochon* stones, especially in oriental climates, where probably the brightness of the light led the wearers to look more to colour than brilliancy in precious stones. In the belts of swords and other articles where they were used, a stone *en cabochon* would have a better effect than a facetted one; and, even in this country, a gentleman who wished to wear a ruby in a ring or a pin might not unnaturally prefer the quieter appearance of a *cabochon* than one which would have a more glaring, and as some might say, vulgar effect. Again, rubies made a beautiful combination with jade, as Professor Church had himself pointed out, but in such a position they would require colour, not brilliancy. Then Professor Church had protested against the use made of irregular monster pearls, by forming them into the representation of some natural object; but as they were formed by nature in these irregular shapes, in which they were altogether inapplicable for necklaces or similar purposes, the jeweller could only use them at all by fashioning them into the shape of a beetle, a bee, or any other form which might suggest itself as being most suitable to the particular pearl. He then condemned some of the common forms of jewellery in this country, particularly the half-hoop ruby ring, because it only showed the rubies. But such a ring was not intended to be worn as a single article of jewellery; it would be accompanied by a diamond ring, or something of the kind, so that one would set off the other. With regard to the moonstone being very suitable for jewellery he would point out that it had no intrinsic value, scarcely more than a pebble or an agate, and, therefore, it would be useless and inconsistent for a jeweller to mount it, because he would find no purchasers. Although these stones might look very well, there would be no means of disposing of them. They might be made into a beautiful work of art for a museum, but for ordinary

purposes they would be useless. The same with regard to spinels. Nobody asked for them, and no shop kept them; if they did, they would not sell them, and therefore they were not mounted. The aristocracy, now-a-days, paid great attention to precious stones, to their qualities, value, and distinguishing peculiarities, and they knew very well that it was not difficult to distinguish these stones from rubies, because they were really much softer. With regard to the emerald being discredited by some people, and considered vulgar, it was just now—only temporarily, he believed —out of fashion. In all ages it had been highly esteemed, and he believed it would always be considered of great value. It had a certain soft beauty which had always been admired, and it formed a beautiful combination with the diamond. In these matters much depended on fashion, and, in the present day, the sapphire was greatly in demand, and therefore it was mounted and sold; and he believed the day of the emerald would come round again, and possibly the jargoon and tourmaline might, at some future time, be in demand also. At present, though they might be curious and beautiful as works of art, they would be useless except for museum purposes. What was wanted was that a higher standard of talent should be employed, in the production of those articles in which precious stones were used for artistic and ornamental purposes. Looking back some hundreds of years, to the time of Benvenuto Cellini, they would find a much higher standard than existed now, for, with all our advances in steam, machinery, and science, we were much behind in such matters. Great progress had been made in architecture, sculpture, and in music, and he hoped the reading of this paper might give a start to this subject also, and that they might see in this country those who possessed higher training and capacity devote themselves, as they did in former ages, to the working up of these highly prized and beautiful productions of nature. In the arts he had mentioned, the practical men were highly cultivated, but in jewellery it was not so; the practical men were mere mechanics, and the designers were only one step higher. They wanted a higher order of intellect devoted to it, and then they might hope to rival the works of former ages, which at present they were far from doing.

Mr. Clements had listened with great pleasure to the paper, but at the same time he thought Professor Church had to some extent put the cart before the horse. Mineralogy was a very difficult subject, and was very little studied, but until it was so, and the public could appreciate the distinction between precious stones, it would not be much use for the jeweller to supply them in a more artistic form; hence he simply made what would sell. He believed the Chairman would bear him out that, in the Science and Art Examinations, only a few hundreds went up for mineralogy, as compared with thousands who studied other subjects, and until it was more cultivated, he feared no advance would be made in the artistic production of jewellery. Prior to 1851 we were much behind France in all art matters, drawing being only taught to a few who were supposed to have a talent for it; now it was taught to almost everyone, and we were becoming an artistic nation, supplying not only designers for our own country, but for others, especially the United States and the Colonies. When mineralogy was also generally taught, we might hope to make similar advances in jewellery. When at the Paris Exhibition, he was much struck with the dexterity of the French in manufacturing jewellery, but he hoped through the exertions of the Society, and the City Guilds Institute, that improvement might be made. At the present time people looked simply to money value, and would not study a subject from which they did not expect to reap a benefit; and it would only be by holding out to jewellers the hope that artistic work would command a higher price, that attention would be paid to the subject, with the result that improvement might be expected.

Mr. Nockold, as a practical lapidary, did not agree with Mr. Price that the cutting of stones *en cabochon* concealed their faults; on the contrary, he thought it would show them up. Again, with regard to moonstones not being more valuable than pebbles, he could say from experience that they were much in demand at the present time, and that plenty of buyers could be found. Emeralds were still very valuable, and would fetch a long price.

Mr. Price said his contention was that the purest stones, as a rule, were not *en cabochon*, and he believed everyone of experience would confirm his opinion. Moonstones were not of any intrinsic value, as compared to precious stones. He was aware that there was a considerable demand for them at present for the American market, where they were used for pebble work.

Mr. William Botly said there were some of the finest precious stones ever collected together at the Paris Exhibition. He remembered in particular two enormous emeralds in a pair of bracelets, several hundred pounds in value, which he had the pleasure of examining. He noticed there was a difference in the colour of them, and though the proprietor would not at first admit that they were not a perfect match, he at last acknowledged that there was a difference, and that one was worth £50 more than the other. They were much indebted to Professor Church for bringing this subject forward, and insisting as he had on the importance of due care and skill in the arrangement of form and colour, for it was only by attention to these points that we could ever hope to rival the French and other workmen. Although Amsterdam had for many years stood almost alone in the cutting of diamonds, he understood that an immense deal was now being done in England. It had been said that the Koh-i-noor had been immensely reduced in size from injudicious cutting. He believed that both the late Prince Consort and the Duke of Wellington were consulted, and were present at the cutting; but if the facts were as represented, it showed the great importance of more perfect knowledge in the manipulation of precious stones.

Mr. C. J. Parton, while quite agreeing with Professor Church that there was little talent displayed in the mounting of precious stones, thought they could hardly wonder at the fact. In olden times jewellery was only worn by a few, and the man who mounted the stones came into direct contact with those who wore them, and he was well paid for his labour. It would be scarcely thought fit to apprentice a boy to an artist, who did not show some artistic talent, but jewellery was taken up as a trade, not as an art, and boys were apprenticed to it as to any mechanical trade without any talent at all. It was simply because there was not sufficient demand for artistic work, that they did not have it. He was quite sure that when the public taste was shown sufficiently to induce men of talent to devote themselves to it, knowing that they would receive that amount of remuneration due to art work, there would be a great improvement. But when a workman simply received an order for one article, and found a gross sold better, he would naturally devote himself to the gross.

Mr. Ford desired to corroborate the remarks which had been made by Mr. Price. He said that *cabochons*, as generally cut, hid the flaws in various stones, and as a lapidary of some forty years' experience, he (Mr. Ford), could confirm that statement, and he knew that in many cases, although not in all, it was adopted for that purpose. Moonstones were very common, and he had sold them in quantities at 4d. and 6d. each. It was not to be supposed that jewellery of fine quality would be associated with stones of that small value. As to the emerald, he would say that

it was the most beautiful stone of any next to the ruby, and he could not imagine how any one could call it vulgar. With regard to diamond cutting, the practice had now so improved and greatly increased in amount, that he believed in a few years' time the trade would be developed in London to the extent that there would be factories, as there were in Amsterdam, having two or three hundred men at work.

Professor Church, in reply, referred to the exact words he had used with reference to cutting stones *en cabochon;* he did not give it as his own opinion, or as the practice, but what had been advanced in several books, and especially in a lecture given by Mr. Ruskin some years ago at Oxford, in which he objected to any facetted stones at all. And there were several others of the same school who had objected over and over again to any facetted stones, good, bad, or indifferent. He did not agree that the commercial value of a material which was fairly hard, and useful for artistic purposes, was the sole criterion as to its employment. If red, blue, or other enamels were used, whose intrinsic value was a very small sum per pound, and most superb ornaments were produced with it in combination with gold and precious stones, why should you not use a lovely, brilliant, hard substance like the moonstone in decorative jewel work. There were one or two specimens in the case on the table which were worthy examples of the exercise of a good deal of labour. It was quite true that the spinel was not quite as hard as the ruby, but it was not very far short of it, as would be seen by the table. His own opinion of the emerald was that it was a lovely stone, and with regard to the jargoon and tourmaline, what they wanted was to lead public opinion to appreciate them. Of course they would not pay; very few people would buy them, but there were some collectors who did buy these stones, and he knew of many pieces of spinel work and jargoon work which had passed into very good hands. It was really not necessary to know much about mineralogy to be able to distinguish these things. An educated, keen sight, and a few simple instruments, used in a moment, would enable anyone to distinguish any of the stones which otherwise were rather difficult to determine without them. Lastly, he would say that the main object of his paper had been to introduce a discussion on the subject, and to show what might be done in various little worked directions.

The Chairman, in proposing a vote of thanks to Professor Church for his paper, said he hoped that a great deal of good would result from it, and that attention would be drawn to the various collections which had been mentioned. He had lived for 25 years at the South Kensington Museum, but he should take an early opportunity of inspecting the Townshend collection with a renewed interest, and he trusted that, out of the million of visitors who honoured the Museum during the year, many would be led to study that collection with more attention. The authorities, after what had been said, would take care to have all the specimens properly labelled, and possibly they might be able to add to the collection some of the specimens of which Professor Church had referred.

The vote of thanks was passed unanimously, and the meeting separated.

MISCELLANEOUS.

BREAD REFORM.

Dr. Graham, the author of the Cantor Lectures on "The Chemistry of Bread-making," delivered in 1879, has published in the *Miller* of the 7th February, a long letter on the subject of what is called "Bread Reform."

Dr. Graham combats many of the statements put forward at the Mansion-house last December, in favour of bread including the bran and husk. He commences by summing up the doctrines put forth by the Bread Reform League as follows:—"1st. That white bread does not contain sufficient albuminoids for dietetic purposes, and that wheat-meal bread does contain sufficient, or, at least, is incomparably better adapted for human food than white bread. 2nd. They assert—or, at least, imply—that the albuminoids of bran are of the same dietetic value to man as the higher albuminoids of white flour. 3rd. They assert that the greater part of the phosphates is removed with the removal of the bran. 4th. They support their views as to the relative merits of whole meal and fine flour by economic considerations, and conclude that the cheaper is by far the better. 5th. They repudiate the universal conclusions arrived at in reference to the relative merits of white and brown bread, as being not due to the dictates of natural instinctive selection of that which is best for man, but to prejudice and an ignorant and debased taste. 6th. They either ignore the impossibility of obtaining a well-piled and well-aërated bread by the fermentation process—or, recognising this, they imply the necessity of the adoption of the Dauglish or other artificial aëration process."

Dr. Graham then proceeds to examine in succession the arguments put forward by various speakers at the Conference. He commences with Miss Yates, the Secretary of the League, who maintains that good nourishing bread is sufficient to support the whole population. To this Dr. Graham objects that bread alone is an insufficient diet for a semi-carniverous animal. The next point taken up is the inferior digestibility of white flour, which is also said by Miss Yates to contain less nourishment. To this Dr. Graham observes that the amount of bread eaten by Frenchmen is a practical argument on the other side, and that it is inconceivable to believe that the white bread of Paris, Vienna, Dresden, or Moscow, all rich in albuminoids, but deficient in bran, could be injurious to persons eating them, and difficult to digest. He says that the reason Frenchmen can easily digest large quantities of bread, is simply because the bran has been eliminated. Some enthusiastic remarks of Miss Yates, as to the probability of pauperism, disease, and misery being abolished by the use of whole-meal bread are condemned by Dr. Graham.

The next speaker was Professor Henslow, who stated that "the grain consisted of two parts—the interior white tissue, which contained a preponderence of starch of but little nutritive value, and the outer layers, rich in gluten phosphates, &c.

To this Dr. Graham replies:—"It will astonish a miller or baker to learn that the fine white flours of France, Hungary, and other countries are of little nutritive value, because deficient in gluten; the fact being that these flours are richer than any of ours in the amount of gluten they contain. Perhaps the Professor meant only to assert that, in the outer skin, the ratio of albuminoids (not gluten, but chiefly cerealine) was high as compared with starch; be this as it may, as reported in your paper, the statement distinctly implies that the greater portion of the interior of the grain, being deficient in gluten and rich in starch, is of but little nutritive value. It is almost needless to add that the statement is erroneous."

Professor Church is the next antagonist, and his statement that the finest flour contains only a small per-centage of nitrogenous substances is contradicted by Dr. Graham. By Professor Church's remarks Dr. Graham is led to comment on the aërated bread in the following terms:—"Here and there an enthusiast—stimulated, it may be, by the absurd tales told of the filthy concomitants of the fermentation process, long since removed by the introduction of mechanical appliances—will eat and try to like aërated bread; but, as thirty years' experience has shown, the world at large will have none of it. Indeed, most of those who

have given it a fair trial, have at last gone back to the sweet "nutty" flavoured product of fermentation. The aëration process of bread-making in Europe, as compared with the fermentation process, is utterly insignificant in its results. In short, on this matter, as on the question of bran and other articles of diet, hasty theorists, taking mere chemical data as a guide, have been prone to dictate to the world as to what it should eat and what it should drink. The world eats and drinks what it likes, not what crude and groundless theory dictates, and in so doing it is, in the long run, right. Here and there an instinctive craving may be wrong perhaps, but, as a rule, where natural preference and so-called science conflict, the latter has gone wrong on some crude and ill-founded assumptions."

Professor Church gave the ratio of albuminoids to starch as 1 to 5 in whole meal bread, but only 1 to $7\frac{1}{2}$ or 1 to 8 in white bread. This assertion is disputed by Professor Graham, who says:—"Even with English flours the ratio of albuminoids to starch is much higher than 1 to 8, and as two-thirds of all the wheat we consume are imported from countries of more favourable climatic conditions, and, therefore, with a higher elaboration of the albuminoids, the statement in regard to our bread is utterly erroneous."

Dr. Graham then goes on:—"The relative dietetic merits of the albuminoids of the bran and the gluten of the interior may now be discussed by me, in the examination of the second proposition, which, briefly put, is that the advocates of bran for human food, basing their views on mere chemical analysis, assert that the albuminoids of bran, and also, as necessarily arising from their blind adhesion to mere chemical data, those of barley, beans, peas, linseed cake, and decorticated cotton cake, if finely ground, are of high dietetic value to a semi-carnivorous animal, such as man. How comes it that the League, while denouncing in no measured language the removal of bran from our bread material, have not logically and consistently, from their analytical standpoint, urged us to go back to the use of peas and barley bread, once so common, and even yet not altogether extinct. Again, considering the high percentage of albuminoids in barley, oats, in beans, peas, and tares, why have they not had the courage of their convictions, and urged that all these should be ground together and used as human food, and not given, as at present, to our cattle, to elaborate into higher products for the satisfaction of our carnivorous instincts? Liebig unquestionably was a great chemist, but he was also human, and therefore liable to err; and considering the state of our knowledge at the time, and the speculative activity of the Giessen philosopher, it is not strange that he arrived at many erroneous conclusions on the question of dietetics. Bearing in mind the cheapness of oats, beans, peas, and feeding barley compared with wheat, how insufficient is the logic of the following:—

"'Dr. Bartlett informed the meeting that Liebig once observed that we made a very bad use of our corn, by eating fine flour ourselves and giving the coarser kinds to our cattle, We also made bad use of our capital, for we paid at the rate of from 10d. to 14d. for food which should only cost us 2d., and we fed our pigs on food costing us 2d., whereas we only ought to pay one farthing per pound for it If we eat the nutritious parts of our grain in the shape of pork instead of flour, Liebig thought, with a good deal of truth, that we were very bad economists, and not very sensible. (Hear, hear, and laughter.) It also followed that we gave bad food to our cattle, whilst we did not keep the best food for ourselves.'

"If the economic argument is to be allowed ignorantly to settle obscure questions of physiology, why did not the speaker urge on to us to eat the materials mentioned above, all cheaper and far richer in albuminoids than wheat, instead of giving them to our cattle? . . . The views held at the so-called conference, based as they are on mere chemical data, and utterly oblivious of the vast difference between the digestive machinery and power of an herbivorous animal, with its complex digestive apparatus, and that of the simple one-stomached semi-carnivorous man, have been over and over again repudiated by the instinctive cravings of mankind. . . . The speakers at the Bread Reform Conference made use of chemical analysis to show that the world is utterly wrong in preferring white bread to brown bread, or whole-meal bread. Instinctive selection and preference is ignorant and wasteful, and chemical analysis is said to prove it, and therefore we must eat bran, or be guilty of sinful waste and crass ignorance of what they are pleased to call science. But why listen to likes and dislikes at all, and not urge upon all the necessity of eating grass, hay, oats, straw, and any other vegetable substance that chemical analysis indicates to be valuable, and that good economy shows to be cheap. This may seem absurd, but it is to what the chemical theories of the bread reformers must drive them, if their common sense be not better than their science. Now, the instinctive common sense of the world has relegated bran, along with grass, beans, and peas to our cattle, and in spite of an energetic and well-meant, though unscientific movement, the world will continue in this course, because based on real physiological necessities of animal digestion and elaboration, and not on hasty scientific, so-called, assumptions. Though a chemist myself, I must protest against obscure physiological phenomena, requiring all the highest powers of the ablest physiologist to be able to do more than guess at darkly, being authoritatively settled by the mere chemical analyst . . . . The ablest physiologists of Europe are unable to explain the obscure phenomena of digestion, elaboration, and repair of the tissues, but none of them would hesitate to reject with contempt statements as to the dietetic value of food substances based on mere chemical analysis. In short, chemical analysis is utterly worthless in settling this question; we require other and more legitimate scientific aid; but even physiology is as yet unable to authoritatively dictate to us in this matter, and when it is in such a position there can be but little doubt that its conclusions will, in the main, coincide with those adopted by the instinctive preferences of man; and these are against bran, beans, and peas, and such like cheap and nitrogenous products."

Professor Graham then discusses the statement that the greater part of the phosphates is removed in the bran. On this point he quotes Messrs. Wanklyn and Cooper, in opposition to Professors Church and Henslow. Dr. Graham then remarks:—"The children of the poor, insufficiently supplied with milk, may be deprived of a sufficiency of bone-forming materials when dieted too largely on bread. This, however, can easily and cheaply be overcome by the addition of precipitated bone phosphate along with salt in the fermentation process, or still more simply by the use of the process already patented for the treatment of yeast for bread-making. This treatment adds bone-forming material to stimulate the yeast organism, and also to increase the quantity of bone-forming matter in our bread. As this process has for its object to replace dear German yeast by cheap and powerful English yeast, this aspect of the question can be readily and economically met."

The fourth proposition is that whole-meal is cheaper than fine flour, and, therefore, economically to be preferred. On this head Dr. Graham remarks that the poor in large towns do not get the finest white bread, but rather bread in which some finely-ground bran exists, and, therefore, he argues that ill-fed, ricketty children must be affected by other causes than the use of white bread."

Dr. Graham then passes on to the sixth proposition given in his list. On this he says:—"I have, in my lectures at the Society of Arts, explained why the ground bran and ground embryo act so injuriously in the fermentation process of bread-making, and have

there shown that these albuminoids, like those in barley meal, have an energetic diastastic action on the starch, producing too much maltose and dextrin, which have an injurious effect on the colour of the baked bread. Again, these albuminoids, together with those found in barley, beans, and peas, have not the resisting elastic action of the gluten of wheat, and, therefore, are unable to produce the light, well-aërated, and easily-digested wheaten bread, such as we find in a good white loaf made by the fermentation process. This matter need not again be discussed in our columns, because your readers have already had the opportunity of studying these lectures in your issues of February, 1880, and subsequent months. It will suffice that I again repeat what is, after all, known to every baker, that finely-ground bran injures the bread by its injurious action in the fermentation process; and, further, that ill-elaborated wheats of our own country, of bad harvest conditions, though richer in albuminoids than that of excellent harvests, are comparatively poor in gluten, the invaluable essential for bread-making and for food. Here I would again state that of all cereals wheat alone can satisfy the conditions of the fermentation process of bread-making, and even with wheat, the inferior—and, from a dietetic point of view, comparatively useless—bran must be removed."

In conclusion, he sums up the statements made by the advocates for the consumption of bran, by saying that, "they fail to support their assertions on the following points:—1st. That white bread is deficient in flesh-formers, but that it is not so if mixed with some finely-ground bran. 2nd. In their contention, explicit or implied, by their strange adherence to chemical analysis, that all albuminoids, no matter the origin, are of equal value to the gluten of wheat and the albuminoids of flesh for semi-carnivorous man. 3rd. In their contention that three-fourths of the bone material of the ash of wheat is removed by the removal of the bran. Further, in using economical and analytical data to support them in their charge of ignorance on the part of the miller, baker, and consumer of bread, they have omitted to urge the far greater superiority, in both of these respects, of beans, peas, barley, linseed-cake, &c., which, from their analytical standpoint, they were bound logically to do. And then remarks that, "the farmer, miller, and baker must strive to improve the dietetic value of our bread in the following respects:—(*a*.) By the early kiln-drying of ill-matured and ill-harvested wheats of our own country. (*b*.) By the judicious admixture of 'hard'—that is, highly elaborated and matured—foreign wheats. (*c*.) By the improvement of our yeast. (*d*.) And lastly, by taking care that the flour of our 'soft,' and too often ill-matured home wheats, be not used in the preparation of the 'ferment' and 'sponge,' but only in the 'dough' stage. Such, it seems to me, are the right methods to adopt in the improvement of the bread of the poor, and not by the admixture of bran, however finely ground. The bran of wheat—like the skin of the potato, turnip, and other vegetable products, is best given to our cattle for elaboration into higher albuminoids for our use, notwithstanding the analytical arguments of the Bread Reform League."

MARBLE QUARRIES OF ALGERIA.

Thirty-four kilomètres north-east of Oran, on the high road to Arzeu and Mostaganem, is the small village of Mefessour; a branch road to the north-west leads to the still smaller village of Kleber. Above this rises the imposing mountain called Djebel Orousse, generally called "Montagne Grise" from its arid, grey appearance. The chain of hills, the highest point of which is about 2,000 feet above the sea, stretches in a north-easterly direction from Cape Aiguille to Cape Carbon, and includes Cape Ferrat. The central part of the range forms an elevated plateau, almost perfectly level, with a superficies of 1,500 or 2,000 acres; it has hardly any soil or vegetation, nothing, in fact, to hide, as Consul Playfair states in his last report, "that it is an uninterrupted mass of marble and breccia, the largest and finest, probably, that the world contains." Consul Playfair gives it as his opinion that, not even in the Mosque of Cordova, which, as regards marble columns, is an epitome of all the finest Roman and Greek temples, is marble of greater beauty or variety to be found, and, as far as quantity is concerned, there is as much, as in all France and Italy together, not excepting the mountains of Carrara. The discovery is due to a Signor del Monte, who was also fortunate enough to discover the well-known quarries of alabaster, called "Algerian onyx," at Ain Tekbulet, near Tlemçen. He purchased them from the Arabs for a mere trifle, at a time when the country was still unsubdued, and when no one could approach them without danger to his life. He has now obtained a concession of the "Montagne Grise" for a long period of years, and on very favourable terms. The area is about 1,500 or 2,000 acres only, but he has also obtained all the land round about in which there is any chance of marble being found, amounting, in all, to 14,400 acres, so as to avoid the possibility of competition. The whole of this area is an uninterrupted mass of marble and breccia, which only requires to be detached and carried away; roads have been made in every direction, so that there is no practical difficulty in doing either. All over the surface of the elevated plateau may be seen circular depressions, marking the sites of Roman quarries, and these, to a great extent, indicate the position of the different varieties. The soil, where any exists, is of a deep red colour, containing small particles of iron ore; mines of the same mineral exist in some places, and have been worked, but there is not a sufficient quantity of the mineral to make this remunerative. The ore has already served its purpose—a much more important one—by imparting an infinite variety of rich tints to the marble and breccia rocks. Consul Playfair remarks, "I almost fear to say all I wish on this subject, lest I should be charged with exaggeration, but in sober truth, during the two days I spent in examining the ground, in every direction I passed from one marvel to another, and left in amazement at the magnificence of the treasure which has so long lain, I will not say concealed, but exposed to the most superficial gaze there." The marble is found not in isolated spots, or in limited quantities, but in boundless profusion, and capable of yielding monoliths of any size. Although many varieties are found in practically inexhaustible quantities, by far the most common is the "Giallo Antico." Of this, great varieties of tint are found, and Signor del Monte states that some of it is precisely similar to that of which the columns of the Pantheon at Rome are made. The most delicate and beautiful, as well as the most valuable, is a marble of an exquisite rose tint, which is capable of being used either in large masses or in the finest ornamentation. Consul Playfair states that he has seen a breast-pin made of it, which could hardly be distinguished from pink coral, and blocks from which the largest columns might be cut. With this rose-tinted marble is also found a rich creamy white, and another variety, pure white; but it is in the breccias that the greatest variety of form and colour is to be found, they are moreover, perfectly homogeneous, the pebbles and the cement which form the mass being of equal hardness, and taking an equally good polish; there is also another advantage, they leave no holes requiring to be filled up with artificial cement when worked. In the Paris Exhibition of 1878, there was a magnificent trophy of marble work in the centre of the Galerie Rapp, exhibited by Monsieur Cantini, of Marseilles, for which he obtained the gold medal. Almost everything connected with this trophy, Consul Playfair says, was obtained from the quarries of Kleber. From inquiries made, it

would appear that the cost of extracting the marble and transporting it to the sea for shipment is not great. The extraction of the blocks costs 50 francs per cubic mètre; the transport to Oran (about 27 miles) costs 40 francs, and to Arzeu (12 miles) 25 francs. Royalties amount in addition to about 30 francs per cubic mètre. It is estimated that the marble could be laid on the quay at Oran for 120 francs per cubic mètre, or landed in London for less than 200 francs. The only other varieties of marble found in Algeria are the Algerian onyx before mentioned, the breccia of Chennonah, of a very inferior quality, and the white marble of Filfila, and other places, which can never compete with Carrara.

CULTIVATION OF THE CHESTNUT IN TUSCANY.

The chestnut tree has existed for centuries in Tuscany, where at one time nearly every hill and mountain side was covered with its foliage. The number of trees existing in Tuscany and Lucca at the present time is estimated at several millions, and the nut and wood have contributed more to the maintenance of the population of some of the districts than any other production; in some places, in fact, wheat, flour and corn meal are entirely superseded by the chestnut flour, which is very nourishing and much cheaper as an article of food The tree grows to the height of 60 or 70 feet, and attains full maturity at the age of 60 years; its vitality and productiveness last for more than 100 years. In many parts of Tuscany it is largely cultivated, and is always raised from the seed or nut; the larger variety of Spanish chestnut is cultivated from grafting on the young trees. Mr. Schuyler Crosby, the United States Consul at Florence, states that there are six different kinds of chestnuts cultivated—the Marone, the Carpinese or Carrara, the Pastinees, the Rossolo, the Romagnuolo, and the Brandigliano. The method of cultivation is as follows:—The chestnut is raised from the fruit, planted in earth which has been softened by being repeatedly worked over. The plantations are generally situated near a stream, and the ground shaded by hedges or trees placed close together. The space set aside for the cultivation of the chestnut is divided into furrows, six or seven feet wide, and in each of them holes are dug about three inches deep, and at a distance of about six inches from each other. In these holes the nuts are placed, with the germs downwards. The use of manure is not largely resorted to, although it has the effect of rendering the plants more vigorous and healthy, as it is dangerous, on account of transplanting, as the young tree, finding itself on soil less rich than it has been accustomed to, easily languishes and dies. After two years the plants are transplanted to another part of the plantation, where they remain four years, after which they are placed where they are destined to remain permanently. The season usually chosen for transplanting is after the falling of the leaves, though it is frequently done even as late as February or March. There are two methods of grafting the tree (which is done at the age of five or six years); one is the primitive method of inserting the bud in the end of a branch, with a slit in it, where it is retained by wax or other substances. The other, which is the latest, and has proved the most successful in its results, consists in cutting large rings of bark from the branches of the large or Spanish chestnut, and placing them on twigs of the ordinary kind; this is a very delicate operation, requiring great care, and is performed in the following manner:—The bark of the Spanish chestnut is cut into circles on the twigs, where marks of buds appear, care being taken to have one or more buds on each circle or cylinder, the bark is then slightly beaten to loosen it from its position, and gently twisted by hand, until a hollow cylinder of bark is obtained, which is then drawn up by the stem, that has been previously denuded of its bark in like manner. The cylinder of bark is then carried to the stem of the tree, which is grafted. This stem, having been previously denuded of its bark, and cut off down to the place where the ring is to be put on, is then covered with the ring, which unites with the growing bark, and sends out shoots of its own variety. In this manner a tree is covered with these rings, and the natural branches being cut down, all the force of the tree is expended in throwing out the shoots of the large chestnut from the grafted branches. Great care is always taken to cut off all shoots of the common chestnut that may appear near the grafted part, as they interfere with the full development of the part grafted. The operation of grafting by rings is practised in Tuscany from the 10th of April to the 1st of May, that being the time when the sap is running most freely, just before the leaves and buds come out. A method of preserving the grafting buds so that they may be good even after a year, is to place them in tin tubes filled with honey, and hermetically sealed immediately on their removal from the tree; another method of transporting the grafting buds, is by putting them into hermetically sealed tubes filled with water; this method can only be used for transporting the buds for distances accomplished under forty days. The chestnut produces flowers which after the usual process of the male pollen being deposited on the ovaries of the female flower, become chestnuts or the seeds of the tree; this change of the flower into the nut takes place about the end of July, and it is easy to foretell the crop of the year by the state of the nut germs, for although the flowers may have been abundant, fecundation may not have taken place largely, and it is only by watching the tree carefully after it has flowered, that a judgment can be formed as to whether the production will be good. The ovaries that are not fecundated by the flowers change into useless shells, but those which are fecundated become enclosed in buds containing one, two, or even three chestnuts. The nuts arrive at maturity in two months after flowering, that is to say, in October, and then fall to the ground; they are also beaten from the trees by peasants armed with long poles, but this is only occasionally done, as it seriously injures future fruit buds, and affects the yield of the tree for another year. The chestnut is pruned and trimmed every three years, which, while helping the tree to bear more abundantly, produces wood for fuel and other purposes, and the smaller twigs and branches, which are dried and used later for drying the nuts. The leaves are also gathered when green and young, and pressed flat in large bundles, and are then used for putting under pats of butter, and in making a kind of cake called "necci."

The Spanish chestnut has been cultivated with more than usual care and success in the province of Lucca, owing to the laws to protect it from destruction, passed by the Lucchesan Republic in the eleventh century. The chestnut is a very healthy tree; in fact, the only disease to which it is liable is internal decay of the trunk. Cases have been known where the whole life of the tree has been carried on through the external bark, while the interior was completely destroyed; the only way to arrest this disease is by burning out the whole of the interior of the tree by a slow fire. After the nuts are gathered, which is done by picking up those which have fallen, and not by beating the tree, they are deposited in huts, in the upper part of which deep trays are constructed on which the nuts are placed to the depth of six inches; in these huts slow fires of green wood are kept up, until they become hard and dry. They are then carried to the mill, where they are ground into flour, in the same manner as corn or wheat. From this flour many preparations are made, such as "polenta," and various kinds of cakes, fritters, and even a heavy kind of bread. The different ways of cooking the chestnut flour are known under the popular names of "necci," "pattoni," "castagnacci,"

"cialdi," "fritelli," &c., and the food so made is sweet and agreeable to the taste. The country people cook the chestnuts in water, and make use of this water as a medicine for chest diseases, colds, and coughs, and in most cases it has proved beneficial. The food made of the chestnut, which is most in favour, is the "polenta," made by simply boiling the chestnut flour in water for ten or fifteen minutes, with a little salt to flavour it, care being taken to keep up a constant movement of the paste, so that no part becomes burnt, which would thus spoil the mess; it is eaten with cream, butter, ham, &c., and is most healthy and nutritious. Another kind of food made from the chestnut is called "necci," which is flour formed into a cake, and is made by first mixing the flour with cold water, and making cakes piled on each other, and separated by chestnut leaves, pressed for the purpose, and moistened by water; the whole mass is then cooked over a hot fire, and the cakes taken off one by one, when the leaves are almost burnt. These cakes are generally eaten with cheese, Bologna sausage, and meat. Consul Crosby states that, in those regions where the inhabitants live almost entirely on the chestnut, they are of better appearance, and as strong as those who live on what is considered more wholesome and nutritious food.

GOLD MINING IN QUEENSLAND.

It appears from a report, issued by the Department of Mines, Queensland, which has just been presented to Parliament, that the approximate yield of gold in the year 1879, amounted to 288,556 ounces, as compared with 309,612 ounces in 1878. This decrease of 21,056 ounces represents a loss of £73,696, and would seem on a superficial examination to be a very severe falling off in the gold yield of the colony. But a decrease was anticipated, owing to the bed of the Palmer River (the principal deposit of alluvial gold) and its auriferous tributaries having been to a great extent repeatedly worked over, and consequently until new auriferous ground is discovered, a falling off must be expected. Although there is this considerable decrease in the quantity of alluvial gold produced, it has not been from the individual earnings of the alluvial miners being less than in the previous year, but from the decrease in the number of that class of miners. There has, in fact, been more gold produced in the Palmer district, relatively to the number of miners working during 1879, than there was during the previous year. This is accounted for by the improved system upon which the Chinese now work, that is, in large gangs sluicing, instead of as formerly, in small parties cradling, and by the discovery of several new patches of ground which, although of small extent, and soon worked out, yet yielded large returns.

The quantity of gold exported in 1879 amounted to 281,552 ounces, and it will be seen that there is a difference of 7,004 ounces between the amount exported, and that actually produced. This is due to the fact that a considerable quantity of gold is carried away in small parcels, by persons who do not make entries of it at the Customs. The number of miners at work in the colony in 1879 shows a decrease, as in 1878 there were 2,980 European quartz miners, 654 European alluvial miners, and 1,095 Chinese alluvial miners, in all 14,490; whereas in 1879, there were 2,750 European quartz miners, 441 European alluvial miners, and 5,621 Chinese alluvial miners, in all 8,812. Mr. Lukin, the under-secretary of mines, explains that this is but a rough statement, as the wardens of the separate gold-producing districts have not the means of obtaining a very accurate estimate; it is possible to arrive at a reasonably correct calculation of the number of settled quartz miners on the older fields, but not of the large floating population of alluvial miners, Chinese, and prospectors, scattered over thousands of square miles of country. The decrease in the number of Chinese, 5,235, is very great; it appears, however, that 889 left one district alone, that of Cookstown, for China, while only 54 have arrived from that country. Numbers have left for southern ports, many have taken to agricultural and other pursuits, a considerable number have dispersed themselves over the many old alluvial fields of the colony, and moving about in parties have no doubt escaped enumeration in the totals returned by the wardens as engaged in mining. Death accounts for a considerable number in the decrease; the death-rate among the Chinese having been abnormally great during the early part of 1879. The falling off in the number of European alluvial miners is accounted for by the exhaustion of the alluvial fields. The decrease in the number of quartz miners has occurred principally on the far northern fields, where many have been disheartened by the difficulties against which they have had to contend, chiefly through the insufficiency of capital necessary to work the ground profitably. The commercial depression, so general throughout the colonies, has debarred the storekeepers, tradespeople, and speculators from backing the working miner as in previous years, when money was plentiful and credit easily obtained. Quartz mining is, however, in a satisfactory condition, as in the principal reefing districts—those of Charters Towers, Gympie, Hodgkinson, Ravenswood, Palmer, and Etheridge and Gilbert—the yield of gold, in 1879, amounted to 175,668 ounces. This amount, though slightly less than that produced in the two previous years, considerably exceeds that for 1876, when it amounted to 151,587 ounces. The decrease, however, is nothing more than the ordinary fluctuation observable in the returns from all established gold fields during a series of years. Mr. Bligh, the warden of the district of Gympie, partly accounts for it by explaining that, in some dividend-paying claims, raising stone has been suspended for a time during the erection of better mining machinery, a change which, though causing an immediate falling off in the production, inevitably leads to a better yield in the future. There is no falling off in the richness of stone at the deeper levels now being worked, and new and promising ground has been opened. Several new reefs, distant about ten miles from the town of Gympie, but within the Gympie Gold Fields, have been tried. A trial crushing from the first one discovered (the Veteran) gave a yield of nearly two ounces to the ton. Equally satisfactory reports come from the other districts. A comparison of the amount of gold won with the number of miners working, shows that the position of the individual miner continues to improve. The actual number of men working was—Europeans, 3,191; Chinese, 5,621; making a total of 8,812. As the total yield of gold for the year was 288,556 ounces, which, at an average of £3 10s. per ounce, represented £1,009,946, it places the earnings of each individual miner at £114 12s. For the year 1878, it was £74 15s. 8d. Excluding alluvial mining, which is mainly carried on by Chinese, and taking quartz reefing, which is exclusively in the hands of Europeans, it appears that the yield in 1879 was 189,741 ounces; total value, £664,094; average earnings of each miner, £250; against 179,038 ounces in 1878, value £626,633; average earning of each miner, £201 9s. 9d.

CORRESPONDENCE.

SIGNALLING BY SOUND.

Attention having been called to the subject of sound signals in your *Journal*, it may not be uninteresting to your readers to know that we have recently invented and patented a sound signal whistle, that will give the

high and low note in contrast, and also in combination. A model of this apparatus has been submitted by us to Admiral Sir R. Collinson, Deputy Master of the Trinity House, Mr. Thomas Gray, Marine Secretary to the Board of Trade, and Mr. Douglass, Chief Engineer to the Trinity House, and experiments were made by us in the presence of those gentlemen at Blackwall, on the 1st January, 1881. We venture to say that this sound signal, if adopted, will prove a great boon to our shipping by preventing collision, and also for coast signal purposes. We shall be glad to give further information of the sound signal on application to

Smith, Brothers, and Co.,

Hyson-green Brass Works, near Nottingham,

The following is the description of the instrument:—We take an ordinary organ-pipe or cylindrical bell, and divide it vertically into two parts by means of a metallic bar or blade, this forming two chambers in one bell. In these chambers regulating and adjustable stops are placed, in order to produce, from each chamber, two distinct notes, one a high sharp-toned note, the other a low bass note. This bell is then secured to a simple apparatus, which admits the steam to both chambers, either separately or in combination. The steam being allowed to act on the chamber on the right hand, gives out a high-toned note, and, on the left, a deep bass note, and by allowing the steam to act upon both notes in combination, it produces a loud, peculiar, harmonious sound, or, if desired, the regulating stop can be so arranged that the high and low notes, when in combination, will produce a discord sound. Distinct and characteristic sounds are also produced by making three or more sounding signal whistles, with notes in combination, each pitched in a different key. The value of this invention consists, not only in giving the high and low notes in contrast and combination, but the bar or blade acts as a kind of sounding board when the steam strikes upon it, thus causing the sound to penetrate to a much greater distance windward than the ordinary whistles can possibly do, in consequence of the sound being diffused equally on all sides, and also in consequence of the wind acting upon the whole volume of steam, which weakens as well as distributes its force. By this invention several notes may be produced separately, and in combination, by placing two or more metallic blades in the cylinder, and with stops to regulate them. We will not further trespass upon the attention of your readers by giving any lengthy remarks upon its application, as already much has been stated by eminent authorities upon the frequent collisions at sea happening on account of no reliable code of sound signals being in use. Our invention supplies this want. The high note may be blown for starboard, the low note may be blown for port, and the two in combination for astern. These sounds may be made continuous, because they are distinct. Besides, its adoption obviates the difficulty now felt on account of the coast fog signals being often mistaken for those of steamers, because the sound produced by our invention is so marked and distinct, that it would be almost impossible to mistake one for the other. This remark especially applies to the sound signal-whistle, which gives notes in combination, and pitched in different keys.

THE ECONOMY OF THE ELECTRIC LIGHT.

The time at my disposal would not allow me to make any reference to the economy of the electric light, when I referred to the recent advances made in this subject on March 30th, but some of the facts I have collected are so interesting, that I venture to supplement my paper by this further note. At the South Kensington Museum, very careful observations have been made on the relative cost of the two systems, *i.e.*, gas and electricity. The Court lighted is that known as the "Lord President's" (or the Loan) Court. It is 138 feet long by 114 feet wide, and has an average height of about 42 feet. It is divided down the middle lengthwise by a central gallery. There are cloisters all around it on the ground floor, and the walls above are decorated in such a way that they do not assist in the reflection or diffusion of the light. The absence of a ceiling—the Court being sky-lighted—is to some extent compensated for by drawing the blinds under the sky-lights.

The experiments commenced about twelve months ago, with eight lamps only on one side of the Court. The system was that of Brush. The dynamo machine was driven by an eight horse-power Otto gas-engine, supplied by Messrs. Crossley. The comparison with the gas was so much in favour of electricity, and the success of the experiment so encouraging, that it was determined to light up the whole court.

The gas engine, which was not powerful enough, was replaced by a 14-horse power "semi-portable" steam engine, by Ransomes & Co., of Ipswich—an engine of sufficient power to drive double the required number of lights. The dynamo machine is a No. 7 Brush. There are sixteen lamps in all—eight on each side of the Court. The machine has given no trouble whatever, and it has, as yet, shown no signs of wear. The lamps were not all good, and it was found that they required careful adjustment, but when once they were got to go right they continued to do so, and have, up to the present, shown no signs of deterioration, although the time during which they have been in operation is nine months.

The first outlay has been as follows:—

Engine and fixing, including shafting and belting	£420
Dynamo machine	400
Lamps, apparatus, and conducting wire	384
	£1,204

The cost of working has been, from June 22nd to December 31st, during which period the lights were going on 87 nights for a total time of 359 hours:—

	£	s.	d.
Carbons	18	9	0
Oil, &c.	4	11	6
Coal	11	14	0
Wages	34	7	6
	£69	2	0

being at the rate of 3s. 10d. per hour of light.

Now, the consumption of gas in the Court would have been 4,800 cubic feet per hour, which, at 3s. 4d. per 1,000 cubic feet, would amount to 16s. per hour, thus showing a saving of working expenses of 12s. 2d. per hour, or, since the Museum is lit up for 700 hours every year, a total saving at the rate of £426 per annum.

In estimating the cost as applied to this Court, only half the cost of the engine should be taken, for a second dynamo machine has lately been added to light up some of the picture galleries, and the "Life" room of the Art School. The capital outlay should, therefore, be £994. In making a fair estimate of the annual cost, we should also allow something for per-centage on capital, and something for wear and tear. Take—

	£	s.
5 per cent. on the capital	49	10
5 per cent. for wear and tear of electrical apparatus	39	0
5 per cent. for depreciation of engines, &c.	21	0
Total	£109	10

leaving a handsome balance to the good of £316 10s. as against gas. The results of the working, both practically and financially, have proved to be, at South Kensington, a decided success.

I am indebted to Colonel Festing, R.E., who has charge of the lighting, for these details.

The same comparison cannot be made at the British Museum, for no gas was used in the reading-room before the introduction of the electric light, but the cost of lighting has proved to be 5s. 6d. per hour—at least one-third of that which would be required for gas. The system in use at the Museum is Siemens's, the engine being by Wallis and Steevens, of Basingstoke.

"An excellent example of economic electric lighting, is that of Messrs. Henry Tate and Sons, sugar refinery, Silvertown. A small Tangye engine, placed under the supervision of the driver of a large engine of the works, drives an 'A' size 'Gramme' machine, which feeds a 'Crompton' 'E' lamp. This is hung at a height of about 12 feet from the ground in a single storey shed, about 80 feet long, and 50 feet wide, and having an open trussed roof. The light, placed about midway, lengthways, has a flat canvas frame, forming a sort of ceiling directly over it, to help to diffuse the illumination. The whole of the shed is well lit; and a large quantity of light also penetrates into an adjoining one of similar dimensions, and separated by a row of columns. The light is used regularly all through the night, and has been so all through the winter. Messrs. Tate speak highly of its efficiency. To ascertain the exact cost of the light, as well as of the gas illumination which it replaced, a gas-meter was placed to measure the consumption of the gas through the jets affected; and also the carbons consumed by the electric illumination were noted. A series of careful experiments, showed that during a winter's night of 14 hours' duration, the illumination by electricity cost 1s. 9d., while that by gas was 3s. 6d., or 1½d. per hour against 3d. per hour. To this must be added the greatly increased illumination, four to five times, given by the electric light, to the benefit of the work; while this last illuminant also allowed, during the process of manufacture of the sugar, the delicate gradations of tint to be detected; and so to avoid those mistakes, sometimes costly ones, liable to arise through the yellow tinge of gas illumination. This alone would add much to the above-named economy, arising from the use of electric illumination in sugar works."

I am indebted for these facts to Mr. J. N. Shoolbred, under whose supervision the arrangements were made.

Some excellent experience has been gained at the ship-building docks in Barrow-in-Furness, where the Brush system has been applied to illuminate several large sheds covering the punching and shearing machinery, bending blocks, furnaces, and other branches of this gigantic business. In one shed, which was formerly lighted by large blast-lamps, in which torch oil was burnt, costing about 5d. per gallon, and involving an expenditure of £8 9s. per week, the electric light has been adopted at an expenditure of £4 14s. per week.

The erecting shop, 450 feet by 150 feet, formerly dimly lit by gas at a cost of £22 per week, is now efficiently lit by electricity at half the cost.

I am indebted for these facts to Mr. Humphreys, the manager of the works.

The Post-office authorities have contracted with Mr. M. E. Crompton, to light up the Post-office at Glasgow for the same price as they have hitherto paid for gas, and there is no doubt that in many instances this arrangement will leave a handsome profit to the Electric Light Company. They are about to try the Brockie system in the telegraph galleries, and the Brush system in the newspaper sorting rooms of the General Post-office in St. Martin's-le-Grand.

W. H. Preece.

OBITUARY.

Earl of Caithness.—James Sinclair, 14th Earl of Caithness, whose death at New York, on Monday, 28th March, has been announced by telegram, was born on the 16th December, 1821, succeeded his father in 1855, and was created Baron Barrogill in the Peerage of the United Kingdom, in 1866. He was elected member of the Society of Arts in 1851, and was Vice-President from 1863 to 1867. He obtained his Fellowship of the Royal Society in 1862. Lord Caithness, many years ago, introduced on his estate in Caithness, a locomotive for working on ordinary macadimised roads; he also invented some railway points of a new description. His inventive genius was likewise displayed in a new machine for washing railway carriages by mechanical means; in an improved compass of great steadiness; and in a tape loom, by which a weaver might stop one of the shuttles without interfering with the action of the whole. He was skilled in photography, and received a prize for a landscape at one of the exhibitions held in the earlier days of the photographic art. At his seat, Stagenhoe-park, near Welwyn, he had two rooms fitted up with photographic and engineering appliances, for experimental purposes. His lordship had the intention of making an extended American tour, but was taken ill on board the steamer, and died from exhaustion, at the Fifth Avenue Hotel, New York, shortly after arrival.

NOTES ON BOOKS.

Notes of Observations of Injurious Insects. Report, 1880. London: W. Swan Sonnenschein, and Allen, 1881.

This report, which contains the result of Miss Eleanor Ormerod's researches on this subject, contains much matter connected with the visitation and ravages of insect pests, and its general circulation amongst farmers and gardeners is likely, in some measure, to assist in the extirpation of many of the most destructive. Regarding the weather and atmospheric conditions generally of the year under review, Miss Ormerod shows that the season of 1880 was remarkably suitable for vegetable growth by its alternations of dry and sunny weather, with storms or periods of rainfall to press on the crops; and from most of the localities where the weather had been thus favourable there are also returns of the small amount of insect injury. The great insect attack of the year was that of the larvæ of the *Tipula oleracea*, commonly known as the daddy longlegs. The carrot and onion flies were also very destructive. As an illustration of the amount of cold the grubs of insects can endure, it may be mentioned that some grubs of the daddy long-legs were frozen by artificial means at the Kew Observatory down to a temperature of 10° below zero, or 42° of frost, and though almost all the grubs died under the experiment, yet it showed that, exceptionally, the grub could survive even this amount of cold, to all appearance uninjured. As a further proof of this, one observer mentions instances where the grubs have been frozen until they were quite brittle, and upon being thawed, were as lively as ever. An experiment as to the effect of salt is recorded, in which a number of cabbages were planted in flower-pots, all the plants being in a healthy thriving state before the grubs were introduced to them. "Salt was then applied upon these occasions, being increased in quantity until plant-life was

destroyed; and, on examination, the grub was found at increased depths in the soil, this depth below the surface seeming to be regulated by the amount of salt applied, but all the grubs were found to be in no way the worse for the application." Soaking in strong brine for twenty-four hours has been tried, but it has not killed them; and shortness of food also for a long time seems also to have but little effect upon them. One observer states that he placed some of them in a glass globe, with a little soil, but no plant food, and three weeks after they appeared all right. The one thing that seems fatal to them is drought. The magpie moth (*Abrax as grossulariata*), and the gooseberry saw fly (*Nematus Ribesii*), were very plentiful on and destructive to gooseberry bushes. Regarding the first, picking the caterpillars off by hand is a good mode of effecting a riddance. This, however, in large gardens, is a tedious operation, and powdered hellebore, scattered over bushes after thoroughly wetting them, so as to make the powder stick, is recommended as "a sure and easily applied remedy." It is necessary, however, to see that the berries are carefully washed before being used, as the powder is a dangerous poison. Syringing with Gishurst compound is also recommended. Several plans are recommended by different observers for the extermination of the saw fly, one of which is that, if pieces of woollen cloth be laid among the bushes, the fly will deposit her eggs on them, and by removing the cloths, they can easily be destroyed. Another plan is to syringe the bushes with warm water in the spring, care being taken not to have the water too warm to injure the young foliage. The best plan, however, seems to be to remove the soil to the depth of two inches round the bushes in the early spring, and to give a good sprinkling of lime round each bush; by this means the caterpillars are cleared away and destroyed.

GENERAL NOTES.

Cinchona in Jamaica.—From a memorandum of Mr. D. Morris, Director of Public Gardens and Plantations in Jamaica (dated January 31, 1881), it appears that, in the hurricane of 18th August last, many thousands of cinchona trees were blown down and uprooted. In consequence, it was necessary to resume barking operations in spite of the unfavourableness of the season. The bark was cured with such success that the whole consignment, consisting of 180 bales, and weighing in the aggregate 14,397 lbs., was ready for shipment within a few weeks of the occurrence of the hurricane. The total results of the cinchona sales during the last fifteen months now show a gross return of 41,696 pounds of dried bark as having been shipped, yielding a total value of £8,167 10s. 8d.

Emigration.—It appears from Mr. Giffien's report, that the excess of emigrants to, over immigrants from, the various countries in 1880 was as follows:—United States, 140,052; British North America, 16,214; Australasia, 18,274; all other parts, 5,995. Compared with the previous year, the increase to the United States alone was 68,000, while the reduction to Australasia was more than 50 per cent. upon the figures of the previous year. In 1876 and 1877, between 60 and 70 per cent, of the whole excess of emigration was to Australaisa; last year it was less than 10 per cent. of the whole. There left our shores for the United States, 69,081 English, 14,471 Scotch, and 83,018 Irish; for British North America, 13,541 English, 3,221 Scotch, and 4,140 Irish; for Australasia, 15,176 English, 3,059 Scotch, and 5,949 Irish; for all places, English, 14,047, Scotch 1,305, Irish, 534. The grand total is 227,542 compared with 164,274 in 1879. Including foreigners, 332,294 individuals left our shores, 281,560 as steerage passengers, and 50,734 as cabin passengers. Of the former 156,150 sailed from Liverpool, 26,058 from London, 19,068 from other English ports; 26,340 from Glasgow; and 53,944 from Londonderry and Cork, all of whom went to the American Continent, in the proportion of 17 to the Republic to one to the Dominion.

Gold Production of the World.—The recent report of Mr. Burchard, Director of the Mint in the United States, contains a *résvmé* of the production of gold and silver for 1879 and the two previous years. The total yields were:—

	Value. Gold.	Silver.
1879	105,365,697 dols.	81,037,220 dols.
1878	119,031,085 ,, ...	87,351,497 ,,
1877	113,947,173 ,, ...	81,040,665 ,,
Total....	338,343,955 ,,	249,429,382 ,,

Or a grand total for the three years of 587,773,337 dollars, or about £146,943,000. The yield of gold and silver in the United States during 1879 was nearly equal, being 38,899,858 dollars of the former, and 40,812,132 dollars of the latter. Australia comes next, with a production of 29,018,223 dollars, all in gold, and she is closely followed by Russia, which furnishes a tolerably uniform annual supply of about 27,000,000 dollars of gold, though but a small quantity of silver. The Mexican yield is almost entirely silver, value 27,000,000 dollars. There has been a considerable falling off in the coinage of the world during 1879 to that of the previous years, the coinage of 1879 being in value 207,287,384 dollars, while in 1878 it was 349,578,524 dollars.

Cardamom Cultivation.—The cultivation of cardamoms is, according to Mr. Markham, carried on to a great extent on the western slopes of the Coorg Mountains. In the month of February, the Coorgs start from their villages, and arriving on the mountain slopes, select one of the largest trees, giving a preference to those on a western or northern slope. Around this selected tree they raise a platform, and commence to fell it. In felling it, they take care that it shall fall towards the base of the slope, and thus, in its fall, carry all before it. Having cleared a space of some 300 ft. long by 40 ft. broad, and freed it from all brushwood, they commence planting. In three months the plants begin to appear; after about 20 months, the plants have reached a height of five feet, and in six months later, that is 26 months after the first sowing, the first clusters of flowers begin to appear. During this period the ground is kept constantly cleared of all weeds. Six months (October) after flowering, the first crop is ready for picking, but a full crop is not obtained till the following year. These plantations are kept up for six or seven years, when the soil having become exhausted, fresh ground is again cleared. The harvesting is attended with some amount of suffering, as the grass which springs up around the cardamom plants cuts like a knife, and large leeches are very abundant. The capsules, when picked, are packed in bags and carried to the villages, a distance, frequently, of ten to twelve miles. Some families have been known to collect cardamoms to the value of 600 to 1,000 rupees per annum.

Petroleum in Venezuela.—A remarkable deposit of petroleum is described by the American Consular Agent at Maracaibo as existing between the Rio Tara and Zulia. Near the former, there rises a sand-bank about 35 yards in extent and some 10 yards in height. On its surface is visible a collection of cylindrical holes, apparently artificially made, and of different diameters, through which streams of petroleum, mixed with boiling water, gush out with great violence, accompanied with a noise as though two or three steamers were blowing off steam. The column of vapour that ascends from it would doubtless be seen from a long distance, were it not shrouded by the thick forest, to which the petroleum beds that evidently lie underneath give a perpetual greenness and freshness of foliage. Dr. M'Gregor states that from one of these holes, notwithstanding the difficulties of the position, he filled, in 42 seconds, a vessel containing 15 bottles, or as fast as four gallons per minute, or 240 gallons per hour, or 5,760 gallons during the 24 hours. A curious phenomenon has been occasionally seen in Venezuela ever since the conquest, consisting of a frequent lightning, without any explosion, which is observable from the bar at the entrance of the Lake of Maracaibo, close to the island of Bajoseco, and which Colonel Codazzi, in his geography, attributes to the vapour ascending from the Cienega de Agua Caliente. This appearance, called by mariners, "El farol de Maracaibo," is more probably due to the inflammable gas that permeates the whole district to such an extent that it is known by the natives as El Inferno. There is no do doubt that the supply of petroleum is very abundant not only here but in the neighbouring Republic of Columbia, where, between Escuque and Bettijoque, the

labourers gather it up in handkerchiefs, which, when saturated, are squeezed out into barrels.—*Times.*

Hours of Labour in French Manufactories.—The following are the regulations as to work in factories definitely proposed to the French Chamber:—Art. 1. The duration of work in factories and workshops must not exceed ten hours a day, or six days a week. 2. Nightwork (between 9 p.m. and 5 a.m.) is forbidden in these establishments so far as women are concerned; but, in the event of stoppage resulting from an accidental interruption, or *force majeure*, the above restriction may be temporarily removed, for a given period, by the local committee or the inspector appointed by the law of 1871. 3. Government regulations will determine the exceptions to the provisions contained in Arts. 1 and 2 on account of the nature of the industries, &c. 4. Any manufacturer or manager acting in opposition to the present law and the Government regulations will be proceeded against, and punished with a fine of from 16 to 20 francs. The fine will be enforced as often as persons are employed in a manner contrary to law, provided that the total amounts do not exceed 500 fr. (£20). On a second conviction within twelve months of the former, the delinquents shall be liable to a fine of from 50 to 500 fr., provided that the total sums do not exceed 1,000 fr. (£40). 5. The local committees and inspectors of children's work in factories appointed by the law of 1874 are charged with the application of the present law, which (6) repeals that of 1848.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

April 27.—"Five Years' Experience of the Working of the Trade Marks' Registration Acts." By Edmund Johnson.

May 4.—"Buying and Selling; its Nature and its Tools." By Professor Bonamy Price, M.A. Lord Alfred S. Churchill will preside.

May 11.—"The Manufacture of Glass for Decorative Purposes." By H. J. Powell (Whitefriars Glass Works).

May 18.—"The Electrical Railway, and the Transmission of Power by Electricity." By Alexander Siemens.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

May 10.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

April 28.—"Impurities in Water, and their Influence upon its Domestic Utility." By G. Stillingfleet Johnson, F.C.S.

May 12.—"Recent Progress in the Manufacture and Applications of Steel." By Prof. A. K. Huntington.

May 26.—"Telegraphic Photography." By Shelford Bidwell. Prof. W. G. Adams, F.R.S., will preside.

Indian Section.

Friday evenings, at eight o'clock:—

April 29.—"The Building Arts of India." By General Maclagan. Andrew Cassels, Member of the Indian Council, will preside.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Four Lectures.

Syllabus of the Course.

Lecture II.—April 11.

Needlework upon a material. Needlework upon separate threads. Venetian needle-point lace. Needle-point and tape lace. French needle-point lace-making centres. English and Flemish needle-point lace.

Lecture III.—May 2.

Fringes. Twisted thread-work in England in the 15th century. Early designs for plaited and twisted threads. Italian, Flemish, French, and English pillow lace. Laces of primitive design.

Lecture IV.—May 9.

Résumé as to styles of design in hand-made lace. Traditional patterns. Sketch of the development of inventions for knitting and weaving threads to imitate lace. Differences between machine and hand-made laces. Modern hand-made laces at Burano, Bruges, Honiton, &c.

This course will be illustrated by specimens of lace. Diagrams and photographs enlarged will be shown by means of the lantern and oxyhydrogen light.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures. May 16, 23, 30.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 11th...**SOCIETY OF ARTS,** John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Alan S. Cole, "The Art of Lace-making." (Lecture II.)
Royal United Service Institution, Whitehall-yard, 3 p.m. 1. Mr. R. Griffiths, "On Recent Experiments in Screw Propulsion." 2. Mr. G. Fawcus, "On Means for Facilitating Handling and Traversing of Heavy Guns."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Colonel H. C. Tanner, with Prefatory Remarks by Mr. R. N. Cust, "Kafiristan and the Siah-posh Kafirs of the Hindu Kush."
Medical, 11, Chandos-street, W., 8½ p.m.
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Mr. N. Whitley, "Supposed Palæolithic Tools of the Valley of the Axe, Devonshire."

Tuesday, April 12th...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-st., Westminster, 8 p.m. 1. Discussion on Mr. B. Baker's paper, "The Actual Lateral Pressure of Earthwork." 2. Mr. W. R. Browne, "The Relative Value of Upland and Tidal Waters in producing Scour."
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m.
Photographic, 5a, Pall-mall East, S.W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Colonial, Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Mr. Thomas Archer, "Queensland, her History, Resources, and Future Prospects."
Royal Horticultural, South Kensington, S.W., 1 p.m.

Wednesday, April 13th...Sanitary Institute of Great Britain, 9, Conduit-street, W., 8 p.m. Address by the Chairman of Council, Dr. Richardson, entitled, "Some brief Suggestions on the best mode of dealing with Small-pox and other Infectious Diseases in the Metropolis and other large Towns."
Graphic, University College, W.C., 8 p.m.
Microscopical, King's College, W.C., 8 p.m. Mr. W. H. Shrubsole and Mr. F. Kitton, "The Diatoms of the London Clay."
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Thursday, April 14th...Telegraph Engineers and Electricians, 25, Great George-street, S.W., 7 p.m. 1. Mr. St. George Lane Fox, "The Application of Electricity to Lighting and Heating for Domestic and other Purposes." 2. Professors Ayrton and Perry, "A Portable Absolute Galvanometer for Strong Currents." 3. Professors Perry and Ayrton, "A New Transmission Dynamometer."
Mathematical, 22, Albemarle-street, W., 8 p.m.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The second lecture of the fourth course was delivered on Monday, 12th inst., by Alan S. Cole, on "The Art of Lace-making." The lecturer treated of needlework upon a material, needlework upon separate threads, and the various kinds of needle-point lace. The third and fourth lectures will be given on May 2 and May 11 respectively.

FOREIGN AND COLONIAL SECTION.

Tuesday, April 5, 1881; John Rae, M.D., F.R.S., in the chair. The paper read was on "Canada: the old Colony and the new Dominion." The paper will be printed in the next number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday, March 24, 1881; Latimer Clark, F.R.G.S., in the chair.

The paper read was on—

THE FUTURE DEVELOPMENT OF ELECTRICAL APPLIANCES.

By Professor John Perry, B.E., Assoc. M.I.C.E.

It had been my intention to introduce this subject to your notice by speaking of the great things physical science has already done for humanity. I assure you, that I had arranged a most effective harangue on this subject, touching on the Bacons, and Newton, and Boyle, and Watt, and Faraday, and Joule, and Thomson, showing that it was these men in their laboratories who opened the way for Stephenson, Wheatstone and Cooke, Gramme, Hughes, Edison, and Graham Bell. I meant to tell you how, in days gone by, a few Birmingham business men subscribed to give their townsman, Priestley, sufficient money to live upon while working at original research; and I felt able to prove so clearly to you, that it was for the good of the nation to provide scientific men with large laboratories, and to ensure them freedom from ordinary cares, that in the mere preface to my proper subject, I prepared an hour's lecture. Luckily, I remembered that you had all had opportunities of hearing about the benefits you owe to science; and I bethought me that you might even be tired of listening to truisms regarding endowment of research; truisms to members of the Society of Arts, but not so well believed in by the general public, and especially by that section of the general public which sees reason to lean on Mr. Ruskin, in whose nostrils the mere names of Watt and Stephenson are as the savoury odours of the Thames at low water, and attends to the views of Sir John Ellesmere, who hated telegrams more than he disliked our common enemy. Men of this stamp may well think of the future with horror, for there is every sign that applied science is increasing the acceleration of the rate of its development. To such men I would say—Put a stop to laboratory work; set your faces against the endowment of research; root up the acorn if you would not in the future be plagued with the oak. The applied science of the future lies invisible and small in the operations of the men who work at pure chemistry and physics. These men do not know what will be the outcome of their labours. They often think that they sympathise with Mr. Ruskin; but you might as well ask a dram-drinker to give up that which his soul loveth, as ask a man who has done real experimental work to give it up. I have often watched Sir William Thomson, to whom every object in nature is continually suggesting new ideas, new experiments; to whom every particle of brass scraped off by a file is a being full of complication, an object of interest, and a thing of beauty, and to whom the study of the bending of a bit of brass wire is a joy for ever. Sir William Thomson believes in applied science, but such belief has really nothing to do with the delight which he and every other experimenter has in his work.

Now, electrical science has reached a position from which, on every side, hundreds of enticing paths lead forward into unexplored regions of nature. At every step in advance, the laboratory worker sees to right and left of him new and promising lines of research; and he feels that, for the work to be done, the present army of explorers is all too small and weak. But interesting as it might be to prophesy on investigations newly begun, it is rather my purpose, to-night, to take you upon the well-trodden ground prepared for us by Faraday, and Joule, and Thomson, to show you how, in one or two great lines of the applied science of electricity, certain fixed laws tell us about the future. I shall then speak of a few of the more recent discoveries.

Now, in the first place, you must remember that electricity is, to us, something that can be measured; although, unfortunately, to the ordinary telegraph operator, this is not the case. If you can imagine a mechanical engineer regarding

a distance of a few inches as being equal to the distance of a few miles, or even of a few thousand miles; if you can imagine a grocer to confound an ounce of sugar with a ship's-load of the same material, you get a too truthful idea of the vagueness, the general want of definiteness, in the notions of nearly all students of this subject until a few years ago, and, I am sorry to say, that much of this vagueness is still to be found even in modern scientific papers. Perhaps, when electricity is supplied to every house in the City of London at a certain price per horse-power, and is used by private individuals for many different purposes, this vagueness will finally disappear.

To get exact ideas in any department of physics, we have one firm foundation to build upon, viz., that a certain amount of energy or power of doing work remains always the same, in whatever form it may appear. I have here various sources of electricity—a voltaic cell, a thermopile, a glass-plate machine, a magneto-electric machine, which may be turned by hand, and two dynamo-electric machines outside, which I can drive by means of a steam-engine. As you know, there are many others. To all these, some form of energy is given, and they convert this energy, badly or well, into electric energy. The cell burns zinc; in the thermopile gas is burnt; to the three last machines mechanical energy is given; they all give out electrical energy. Now, how do we know that there is a production of electrical energy? Let us take any one of them (this voltaic cell, for instance). Some form of energy is given out, for you see that I can convert it into heat. (Experiment shown.) Here I take advantage of a property somewhat analogous to mechanical friction.

This thermopile is also generating electricity. To test this I connect its poles to the wire of a galvanometer, and the instantaneous deflection of the needle of the galvanometer tells me about the current. (Experiment shown.) Here is another proof that some kind of energy is traversing the wire connecting these two screws. The two wires are attached to an arrangement at the other end of the room; when I complete the circuits, whether I do it here or there, the bell rings. (Experiment shown.) You see that in this case the heat energy given out by this burning gas is converted partly into electrical energy, in which state it can be transmitted to a considerable distance, and there converted into mechanical energy, or into sound, or into any other form of energy. In these and other ways we can detect the existence of the electrical energy coming from all these generators, and measure its amount. Now, Joule's experiments tell us that any generator gives out exactly as much energy as is given to it, but much appears in the form of heat. All these generators get heated, and may be said, therefore, to waste energy. One great object of the inventors of such machines, is to give out as much as possible of the energy supplied to them in the shape of electrical energy. You must clearly distinguish between electricity and electrical energy. A miller does not merely speak of the quantity of water in his mill-dam; he has also to consider the height through which it can fall. A weight of one thousand pounds falling through a distance of one inch represents the same energy, that is, gives out the same amount of work in falling as one pound through one thousand inches. A mere statement, then, of the quantity of electricity given out by a machine is insufficient; it is also necessary to state what is the height or difference of potential through which it is falling. The quantity of electricity in a thunder cloud is comparatively small, but the difference of potential through which this quantity passes when discharge occurs is exceedingly great. So it is with the two factors of the electrical energy developed by this glass machine. The quantity of electricity obtainable from this machine is comparatively small, but it is like a small quantity of water at an exceedingly great height, whereas, in all these other machines we have, in the analogy of the miller, a very great quantity of water and a very small difference of level. I put this water analogy before you because you have all more or less exact notions about water, and because, within certain limits, the analogy is a very true one. I have traced it more fully in the wall-sheet I.

Wall-sheet I.

We Want to Use Water.	*We Want to Use Electricity.*
1. Steam pump burns coal and lifts water to a higher level.	1. Generator burns zinc, or uses mechanical power, and lifts electricity to a higher level or potential.
2. Energy available is, amount of water lifted × difference of level.	2. Energy available is, amount of electricity × difference of potential.
3. If we let all the water flow away through channel to lower level without doing work, its energy is all converted into heat because of frictional resistance of pipe or channel.	3. If we let all the electricity flow through a wire from one screw of our generator to the other without doing work, all the electrical energy is converted into heat because of resistance of wire.
4. If we let water work a hoist as well as flow through channels, less water flows than before, less power is wasted in friction.	4. If we let our electricity work a machine as well as flow through wires, less flows than before, less power is wasted through the resistance of the wire.
5. However long and narrow may be the channels, water may be brought from any distance, however great, to give out almost all its original energy to a hoist. This requires a great head and small quantity of water.	5. However long and thin the wires may be, electricity may be brought from any distance, however great, to give out almost all its original energy to a machine. This requires a great difference of potentials and a small current.

You will readily understand then that for some purposes it is necessary to have our electrical energy in the shape of a small quantity of electricity falling through a great difference of potential, and for other purposes a great quantity of electricity falling through a small difference of potential. When electricity falls through a difference of potential, this difference is called an electromotive force. It would take me too long to tell you why we use two terms to express what seems to be the same thing; but briefly, the term "difference of potential" is analogous with "difference of pressure" or "head" of water, howsoever produced; whereas electro-motive force is analogous with the difference of pressure before and behind a slowly moving piston of the pump

employed by an unfortunate miller to produce his water supply.

The first object of my paper is to show you that electricians have very definite ideas on the subjects they are working at; that the measurements, on which their work depends, have exact meanings, and that there is hardly any problem in adding to man's powers which you can set before them to solve which they may not hope to do with more or less costly apparatus. Everybody knows that the civil engineer is still very far from having reached the limiting lengths or sizes to which large bridges and other structures may be built, at a greater or less cost. Everybody is competent to form a roughly correct judgment in such matters, because everybody has more or less correct notions about sizes, weight, and strength of materials. And in the same way that you may be able to guess of what the electrician may do in the future, it is necessary that you get fairly correct ideas of electrical magnitudes; and the curious fact is that, seeing how simple it is to arrive at these correct ideas, so few people possess them. On the wall-sheets II and III, I have given such help as can be given visibly in this matter; but time will not allow of my entering into such explanatory details as I should desire.

Wall-sheet II.—Electrical Magnitudes.

(some rather approximate.)

Resistance of

One yard of copper wire, one-eighth of an inch diameter	0·002 ohm
One mile ordinary iron telegraph wire	10 to 20 ohms
Some of our selenium cells	40 to 1,000,000
A good telegraph insulator	4,000,000,000,000

Electromotive force of

	Volts.
A pair of copper-iron junctions at a difference of temperature of 1° Fahr. .... =	0·000,01
Contact of zinc and copper .... =	0·75
One Daniell's cell................ =	1·1
Mr. Latimer Clark's standard cell.. =	1·45
One of Dr. De la Rue's batteries.. =	11,000

Lightning flashes probably many millions of volts.

Current measured by us in some experiments:—

	Weber.
Using electrometer...... =	almost infinitely small currents.
Using delicate galvanometer.... =	0·000,000,000,040
Current received from Atlantic cable, when 25 words per minute are being sent ...... =	0,000,001
Current in ordinary land telegraph lines .... =	0·003
Current from dynamo machine.. =	5 to 100 Webers

In any circuit, *current* in webers = *electromotive force* in volts ÷ *resistance* in ohms.

Wall-sheet III.—Rate of Production of Heat, calculated in the shape of Horse-power.

In the whole of a circuit = *current* in webers × *electromotive force* in volts ÷ 746.

In any part of circuit = *current* in webers × *difference of potential* at the two ends of the part of the circuit in question ÷ 746.

Or, = square of current in webers × resistance of the part in ohms ÷ 746.

If there are a number of generators of electricity in a circuit, whose electromotive forces in volts are—E_1, E_2, &c., and if there are also opposing electro-motive forces, F_1, F_2, &c., volts, and if C is the current in webers, R the whole resistance of the circuit in ohms, P the total horse-power taken in at the generators, Q the total horse-power converted into some other form of energy and given out at the places where there are opposing electromotive forces, H the total horse-power wasted in heat, because of resistance, then—

$$C = \frac{(E_1 + E_2 + \&c.) - (F_1 + F_2 + \&c.)}{R}$$

$$P = \frac{C}{746}(E_1 + E_2 + \&c.);\ Q = \frac{C}{746}(F_1 + F_2 + \&c.);$$

$$H = \frac{{}^2CR}{746}$$

The lifting-power of an electro-magnet of given volume is proportional to the heat generated against resistance in the wire of the magnet.

The future of many electrical appliances depends on how general is the public comprehension of the lessons taught by these wall-sheets. If a few capitalists in London would only spend a day or two in learning thoroughly what they mean, I am quite sure that electrical appliances of a very distant future would date from a few months hence.

It is not necessary for me to tell you now that electrical energy may be produced. Nor need I waste time in speaking of how it may be transmitted to a distance by means of insulated metal wires. A more important fact is that, when electricity is flowing in a wire, I can transform part of its energy into other shapes. For instance, here is an iron wire of 2 ohms resistance. Suppose this to be in a cold room, and I turn on the electricity tap. (An electric machine, driven outside by a gas-engine, is here my source of energy.) This wire is now getting a supply of electrical energy, and is converting it into heat. Mr. Andrews tells me that there is now a current of 20 webers flowing through the wire, and hence the wire is giving out more than one horse-power in the shape of heat. Some of you may have thought that very little heat can be given out by such a wire; but these are the exact figures, and you can all see that they represent a pretty large supply. When the current has been flowing for a short time, the neighbourhood of this wire will be found unpleasantly warm, and I can assure you that the use of this instrument for certain measuring purposes is very disagreeable in the summer time. It is hardly necessary to say that a wire, through which a current is flowing, may be made to give out its heat for a great variety of purposes. The temperature may be pretty much what we please. Thus, I turn the tap, and this wire gives off very intense heat. (Experiment shown.)

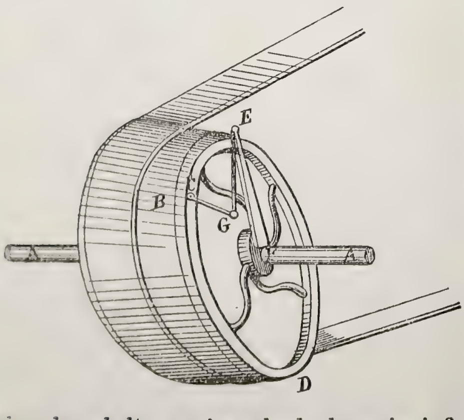
I had asked my friend, Mr. Andrews, to boil water for you by means of a hot spiral of wire; but he has given us something of his own which is very much better. You see that I turn this tap, and so pass this current among all these little bits of carbon; first we have bright spots of light here and there stealing from point to point; then these lights fix themselves in definite places, and round them the carbon gets red hot, until we get in two minutes the most perfect form of fire for

heating a room or boiling a kettle that I have ever seen. I have in vain tried to get Mr. Andrews to exhibit before you to-night his exquisitely simple plate electric light. I have watched it burning, and know that it has a future before it, if it were only from the fact that it burns steadily for a whole week with a powerful arc light without renewal of the carbons, and yet these carbons might be put in one's pocket, and the lamp thrown about anyhow, without risk of anything getting out of order. The excessive caution of the inventor prevents my showing you this simple little lamp. My own lamp is here before you, but beyond telling you that it is very simple, and that only one magnet is employed in the regulation and separation work, I may not detain you. I now turn another tap, and the strip, through which the current passes, becomes white hot, and we call it, vaguely, an electric light. (Experiment shown.) This is the incandescent light which has been proposed for use in ordinary houses. It is, confessedly, not economical, but it is very convenient for chamber use. I now turn another tap, and you see a powerful Serrin lamp, which I mean to leave burning. You know now that we can convert electrical energy into heat and light; but the question is, how much of a result do we get for the power expended?

Professor Ayrton and his students measure at Cowper-street, 1st, how much gas is being used by his gas-engine; 2nd, how much horse-power is being actually given to his electric machine; 3rd, how much current is produced through external circuits by his machine; 4th, the resistance of these circuits. He can now calculate exactly how much horse-power is expended in any part of these circuits; and also how much light is actually given out by an electric lamp.

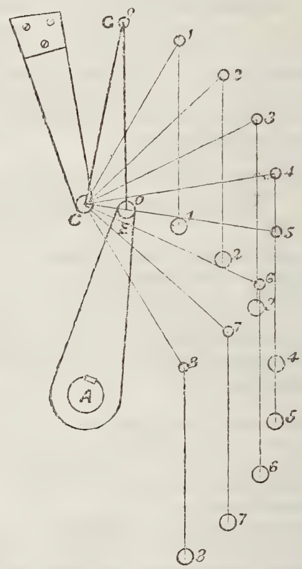
I must now try to give you an idea as to how these measurements are made. The very elegant dynamometer employed by our Chairman to measure the power which is being transmitted to a machine, I am not at liberty to describe. The plan devised by Professor Ayrton and myself is capable of being applied at very small cost to existing shafting in factories, so that the power given to any shaft may be known. A is a shaft which is to receive power. B is a loose pulley

Fig. 1.



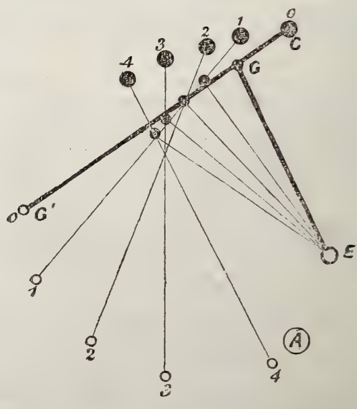
driven by a belt. C D is a wheel whose rim is fixed to the rim of B; its crooked arms are made of flexible steel, its boss being keyed to the shaft. Evidently B can no longer be called a loose pulley, if it turns it must cause the shaft to turn, but the turning moment is accurately represented by a certain amount of yielding of the steel arms of C D. If this yielding is known, and also the speed, the horse-power transmitted is also known. For, so far, we copy the principle of General Morin. But instead of using his elaborate system of measurement, we simply convert the tangential strain into a radial motion which is visible. This may be done in various ways, of which the following is the most simple. A stiff arm, E A, is fixed to the shaft at A; at E and at a point C of the wheel, the ends of two light links are pivoted, which are hinged together at G, where there is a bright bead. Evidently, if the distance C E becomes large, because much power is being transmitted, the bead G moves

Fig. 2.



Another arrangement, giving greater rang

Fig. 3.



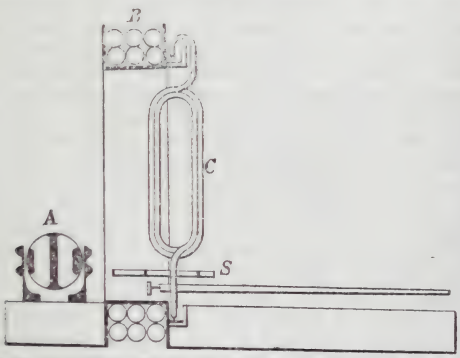
When tangential strain is small, this method of used

out from the centre, and therefore the circle of light described by it has a greater radius. The arrangement shown in Fig. 3 is sometimes more convenient.

We measure the distance of the bead from the axis by means of a scale supported level with the shaft. Other dynamometers, which have till now been in use are shown in the diagrams. For measuring very strong currents, such as are used in electric lighting, Professor Ayrton and myself have devised this "dead-beat" galvanometer. Without going into a detailed description of the instrument, I may mention that it possesses the following great advantages. Not only can the strength of any current be read off at once in webers, but the user can at any moment test his own instrument, or graduate it, as it is technically called, by employing only the weak current produced by a single Daniell's cell. This result is arrived at by the device of causing the weak current to circulate 60 times round the magnets, while the strong current only goes round six times; a special form of commutating arrangement enabling the very same wires in the galvanometer to serve for both strong and weak currents; hence, comparisons can be made, not merely approximately, but with absolute accuracy, even if the wires are wound on the galvanometer quite carelessly.

The instrument shown in this diagram may be graduated in the same manner, as it is also provided with the same kind of commutator. We call it an

FIG. 4.

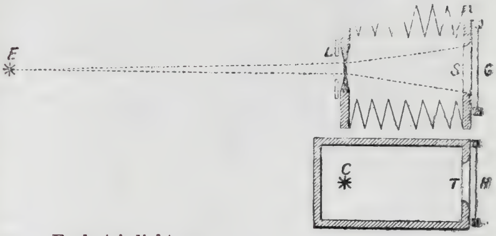


B, fixed coiled cable of ten strands, which may be used in "parallel arc" or in "series," by means of the commutator, A.
C, moveable coil.
S, spiral spring.

arc-horse-power measurer, because its deflections are proportional to the product of difference of potential established in an electric light, into current flowing through the arc, or incandescent carbon, and hence these deflections (see wall-sheet II., p. 459) show at a glance the horse-power given out at that place. The electro-dynamometers of Dr. Siemens and of Mr. Andrews are here before you, and may be used during the reading of the paper to measure currents. Mr. Andrews simply uses a steel-yard to balance the attraction between two coils, when the current flows in them, when they are at a fixed distance asunder, and he, therefore, like Dr. Siemens, measures the mean square of the current flowing. These instruments have the disadvantage that an ordinary pair of scales has in comparison with a spring balance, viz., that a sudden temporary change in the thing weighed cannot be measured; but they have the advantage of great accuracy in the measurement of a constant effect.

To measure the light itself in standard candles, the students in the course of electric lighting, at Cowper-street, employ our photometer (Fig. 5), of which three specimens are before you, and there is an enlarged drawing on the wall. The principle

FIG. 5.—DISPERSION PHOTOMETER.



E, electric light.
C, standard candle.
S and T, screens of tissue paper.
G, H, plates of green or red glass.
$E, \propto \frac{E L^2 . L S^2}{C T^2}$

of old methods of measurement of strong lights was to weaken the intensity of illumination of a screen by taking the screen far enough away. Only in this way could the illumination of the screen by the electric light be made equal to the illumination of a similar screen by a standard candle. Our plan of weakening the light from an electric lamp is not by going forty or eighty feet away from it—for people who deal with electric lamps do not often possess a large enough chamber with blackened walls—but by letting, instead, the light pass through a concave lens. The principle is then exceedingly simple. Mr. Wormell has been making a few measurements whilst I have been talking, and I see that this electric light seen through green glass has varied from 2,214 to 2,136 candles in the last three minutes. Sir William Thomson suggested to us to make two measurements, one through green and the other through red glass, for reasons which must be obvious. Anyone who may wish it will have an opportunity of measuring the power of an electric light for himself after the lecture.

From all this you will see that perfect methods exist for measuring the power which is being given out as heat or light in any part of a circuit, as well as the power given to the electrical machine. In fact, we have a perfect measure of what is called the efficiency of our arrangement.

It is hardly necessary to tell you that every house and every street may be lighted electrically. Into the proof that, in the future, arc lamps of thousands of candle power at elevations proportional to the square roots of their powers, will be used for large spaces, and that incandescent lamps of only hundreds of candle power are suitable only for private houses; into a consideration of these statements I shall not enter, because Professor Adams is dealing with the question in his Cantor lectures. You all, in one way or another, feel that electric lighting is a foregone conclusion. But, perhaps, you were not aware that buildings may

be heated by electricity. The neighbours of this iron wire will say that it gives out a considerable quantity of heat, but whether the heating may be performed economically will depend on the story told us by the measurements which have been made. Now let me turn my tap again. I let my current pass through this insignificant little dynamo machine, and you observe that it is in motion; not only is it in motion itself, but it is driving this lathe. A machine is receiving mechanical energy outside, it converts this into electrical energy, which is conveyed by wires into the room and to the machine before you, where it is converted into mechanical energy again. I think I shall never forget the astonishment of a workman in Sheffield, who had put up a saw-bench for use at Professor Ayrton's lecture, and who was about to rehearse his part. He looked at the motionless saw, he had his hand on the wood, he saw there was a belt from a little mite of an electric machine, two wires dangled from the ceiling to the machine, and this was all. What notions of being played with came into his mind I do not know, but when, at the distant place, a water-engine was started to drive the distant machine, when the saw set off nearly at its full speed, and the two dangling wires were evidently the only methods of communication, this thoughtful workman's face expressed in full perfection the absence of all his reasoning powers. I do not wish you to lose your reasoning powers, but it is necessary that you should get thoroughly impressed with the notion that the power to drive this lathe is actually being transmitted through these limp and motionless wires.

I should like to be able to hold that machine motionless, and to prove to you that the current flowing through the wires is immediately diminished when the machine begins to move. In fact, I want to show you that this machine produces an electromotive force, which is in opposition to that of the distant machine. You see that we are just able to hold it, and now I am informed that the current flowing is 19·5 webers, whereas if we let it run, and drive the lathe and the sewing-machine and this fan, you will find that the current is diminished. It is 11·2 webers, or about half what it was before. It is not necessary to give you further examples of this transmission of power by electricity, but on account of the evident importance of the matter to the health of the community, I will give you one more, and I turn the tap, and you all see that the insignificant little machine is driving a ventilator. This ventilator might be used in a chimney in the summer time when fires are not in use, or in any suitable outlet from rooms; and pray remember that mechanical ventilation is ever so much more efficient than what is called natural ventilation, in which advantage is taken of the lightness of warm gases.

Now, what do these examples show you. They show that if I have a steam-engine in my back yard, I can transmit power to various machines in my house, and if you measured the power given to these machines, you would find it to be less than half of what the engine driving the outside electrical machine gives to it. Further, when we wanted to think of the heating of buildings and the boiling of water, it was all very well to speak of the conversion of electrical energy into heat, but now we find that not only do the two electrical machines get heated and give out heat, but heat is given out by our connecting wires. We have then to consider our most important question. Electrical energy can be transmitted to a distance, and even to many thousands of miles, but can it be transformed at the distant place into mechanical or any other required form of energy, nearly equal in amount to what was supplied? Unfortunately, I must say that hitherto the practical answer made to us by existing machines is, "No;" there is always a great waste due to the heat spoken of above. But, fortunately, we have faith in the measurements of which I have already spoken, in the facts given us by Joule's experiments, and formulated in ways we can understand. And these facts tell us that in electric machines of the future, and in their connecting wires, there will be little heating, and therefore little loss. We shall, I believe, at no distant date, have great central stations, possibly situated at the bottom of coal-pits, where enormous steam-engines will drive enormous electric machines. We shall have wires laid along every street, tapped into every house, as gas-pipes are at present; we shall have the quantity of electricity used in each house registered, as gas is at present, and it will be passed through little electric machines to drive machinery, to produce ventilation, to replace stoves and fires, to work apple-parers, and mangles, and barbers' brushes, among other things, as well as to give everybody an electric light.

Probably you think it very strange that I should show you the inefficiency of electric transmission of energy, and then make this very bold assertion. Well, the fact is, that the ordinary electrical machines in use have not been constructed with a view to economy. They have been constructed to show that brilliant lights and considerable power may be produced from small machines. They have, at a comparatively small cost, attracted attention to the fact that electricity is an important agency. In so far they have done well; but on the other hand they gave rise to the well-known assumption that 50 per cent. of the mechanical power given to the generator, was the maximum amount which could be taken from the motor. The true solution of the problem of transmission of power was, I believe, first given by Professor Ayrton in his British Association lecture at Sheffield. It had been supposed that to transmit the power of Niagara Falls to New York, a copper cable of enormous thickness would be needed. Mr. Ayrton showed that the whole power might be transmitted by a fine copper wire, if it could only be sufficiently well insulated. He also showed that, instead of a limiting efficiency of 50 per cent., the one thing preventing our receiving the whole of our power was the mechanical friction which occurs in the machines. He showed, in fact, how to get rid of electrical friction. I will briefly give you our reasons. A machine at Niagara receives mechanical power, and generates electricity. Call this the generator, and remember that wall-sheet III teaches us that the mechanical power is proportional to the electromotive force produced in the generator, multiplied into the current which is actually allowed to flow. Let there be wires to another electric machine in New York, which will receive electricity, and give out

mechanical work, as this machine does here. Now, I showed you a little while ago, that this machine, which may be called the motor, produces a back electromotive force, and the mechanical power given out is proportional to the back electromotive force, multiplied into the current. The current, which is, of course, the same at Niagara as at New York, is proportional to the difference of the two electromotive forces, and the heat wasted is proportional to the square of the current. You see then, from wall-sheet III, that we have the simple proportion—power utilised is to power wasted, as the back electromotive force of the motor is to the difference between electromotive forces of generator and motor. This reason is very shortly and yet very exactly given in wall-sheet IV.

WALL-SHEET IV.

Let electromotive force of generator be E; of motor F. Let total resistance of circuit be R. Then if we call P the horse-power received by the generator at Niagara. Q the horse-power given out by motor at New York, that is, utilised. H the horse-power wasted as heat in machines and circuit. C the current flowing through the circuit.

$$C = \frac{E - F}{R}$$

$$P = \frac{E\,(E - F)}{746\ R}$$

$$Q = \frac{F\,(E - F)}{746\ R}$$

$$H = \frac{(E - F)^2}{746\ R}$$

$$Q : H :: F : E - F$$

To put it more shortly still, the power wasted is proportional to the square of the current flowing, whereas the power utilised is proportional to the current, and also to the electromotive force of the motor. The greater, then, we make the electromotive forces, the less is the loss of power in the whole operation. Perhaps you will see this better from the water analogy. A small quantity of water flowing through a water-main, may convey a large amount of energy, if it only has sufficient head. The frictional loss of power is independent of the head, but depends very much on the quantity of water. In the model before you is the water analogy. (Experiment shown.) A is a reservoir, kept filled with water by a steam pump, which draws the water from the sea level, K K. Water flows from reservoir A to distant reservoir, B, where it drives a turbine giving out work due to its head, B K. The current from A to B, through the communicating pipe, is the same always, so long as A and B are at the same difference of level, and therefore the frictional loss of energy is always the same, whereas the work utilised from B, by driving the turbine, increases proportionally to the height of B above sea level.

The result, then, to which the above laws led Professor Ayrton and myself was that for the future development of the transmission and distribution of electric energy it will be necessary to use electric machines of great electromotive force. Indeed, so important must this principle become, that we believe there is a future in this direction for the employment of plate electrical machines, such as that of Holtz. Now the electromotive force of an electric machine may be increased in three ways:—1. By increased speed, as you easily see when I turn this magneto machine more rapidly. 2. By increased strength of magnetic fields. 3. By increasing the length of wire on the moving armature. Of these methods the first is most important. Now, if iron is used in the armature, since it is magnetised and demagnetised very rapidly, its coercitive force prevents this magnetisation and demagnetisation being as complete at the high speeds I contemplated as it is at the ordinary speeds of the present day. I say this in spite of the fact shown by some unpublished experiments of ours, which imply that the magnetisation and demagnetisation of a bundle of fine soft iron wires are as complete when effected sixty times per second as when effected once per second. Besides this, a very considerable quantity of heat is developed in such rapid magnetisation and demagnetisation as does occur. The electric machines of the future will, I am convinced, be without iron in their movable parts. High speeds necessitate careful construction and the balancing of moving parts, and great attention being given to rubbing surfaces. By rubbing surfaces, I do not merely mean the bearings of the machine, but the commutator, which is rubbed by the collecting brushes. Much of the waste of energy by mere mechanical friction which occurs in electric machines occurs at the brushes; but, hitherto, other waste has been so great that this might be neglected as unimportant. But it is very important in the machines of the future. The loss of energy by friction is proportional to the number of revolutions per minute, and to the diameter of the rubbing surface. I have given considerable thought to the reduction of this friction, and have arrived at a form of commutator shown at A in the diagram (Fig. 4), which largely diminishes the loss. The parts of the commutator must be firmly fixed, but they must also be well insulated from one another, therefore they must be separated by some rigid insulator, such as ebonite, at the places where they are screwed up; hence they are necessarily far apart at these places. If they are rubbed at these places, however, there will be a great loss of power in friction, and hence they ought to be bent in towards the axis of rotation, where they may be insulated from one another by narrow air spaces, and where they may be rubbed by the brushes, with only a small waste of energy. This plan I have proved to be quite feasible. In the larger machines of the future, its importance will become much more manifest than it can be in existing machines. This frictional principle is illustrated by the model before you. Here are two surfaces, making the same number of revolutions per minute. If the same amount of rubbing occurs, you observe that when I rub the surface of larger diameter, there is great loss of energy, and the motion is stopped; whereas, when I rub the surface af smaller diameter, there is only a small loss of energy, and the motion is not stopped. (Experiment shown.)

This necessity for a great velocity of moving

coils past fixed magnets, necessitates increase of size of the armature, because for a given velocity the centrifugal force tending to burst the revolving armature is inversely proportional to the radius. For instance, here are two light wheels, made in exactly the same way. You can examine their construction at the end of the meeting. They are rotated at a different number of revolutions per minute, so that the actual velocities of their rims shall be the same. You observe that the rim of the smaller bursts in pieces, and the larger is unhurt.

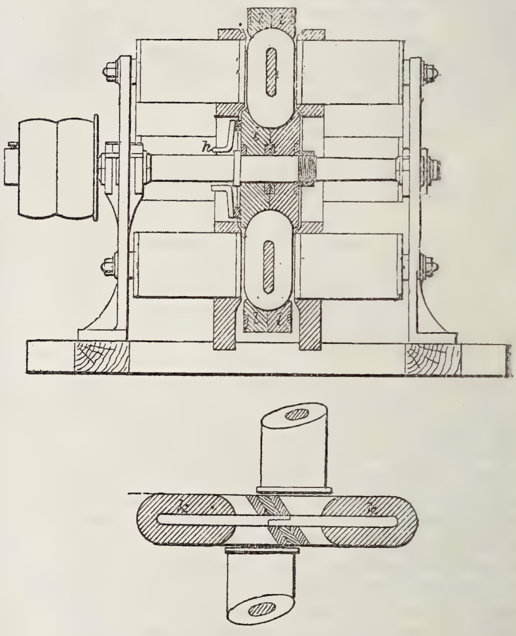
There is another important reason for increased size, namely, that of similar dynamo machines, one twice as large as the other; the larger is capable of giving out eight or more times as much energy for the same number of revolutions per minute. It would delay me too much to go into this question of size fully; but if it be remembered that the electromotive force of each moving coil is proportional to its area, then, without taking into account, increase of strength of magnetic field, which certainly occurs with larger machines, we get eight times as much effect for double the size. Electric machines of the future will then, probably, be of great size, moving with exceedingly great velocity.

The third method of increasing the electromotive force by having greater lengths of wire in the armature is always available, but inasmuch as every increase so produced causes a proportional increase in the resistance of the circuit, and therefore a waste by heating, this method is not quite so economical as the increase of speed method.

It is to be remembered that the lifting power produced in an electro-magnet of given size is simply proportional to the heat produced in the wire on the magnet, and if it is our object to diminish this heat, we must discard all idea of working the magnets of electric machines by their own currents. In fact, the function of dynamo-machines, like these I have been using, will, in the future, be to feed the magnets of larger machines, or else they will give place altogether to magneto-electric machines. I have now given you, very briefly, some of the reasons which have occurred to us for believing that very large continuous current machines, with separate exciters, or, perhaps, even magneto-electric machines, driven very fast by steam-engines, will have an important place in the future transmission of energy by electrical methods. With such machines it would be possible to heat, light, and ventilate all the houses in New York, and to give to large and small workshops the power required to drive their machinery by means of an ordinary telegraph wire (but with some exceptionally good method of insulation), transmitting energy from as great a distance as the Falls of Niagara.

When I speak of what will be done in the future in this direction, I can speak with perfect certainty. It is useless to tell us that existing machines are not economical. As I have already said, existing machines have been made with a very different purpose; to show that much electrical energy and striking light effects may be produced by a small and portable machine. They have drawn the attention of capitalists to electric lighting and electric railways, and in this way have done great service. Calculations of possible economy in the future, deduced from their action merely, must, however, be quite misleading. But if the facts given in this wall-sheet are correct—and, fortunately, there can be no doubt of their correctness—the practical transmission of all kinds of power to all distances, the supply of large and small quantities of light and machine power to all parts of a city like London from a single centre, and a consequent return to that old state in which in many trades it was possible to dispense with the congregation of great numbers of men in large manufactories, is a thing to be looked forward to with perfect certainty. I need hardly tell you that heating houses by electricity will completely get rid of the smoke nuisance. I have been dealing with general principles, and electricians will take various plans to carry out the idea put before you. In my own machine, exhibited here, and also drawn upon this diagram (Fig. 6), I have endeavoured to carry them

Fig. 6.—Perry's Dynamo Machine.



out in my own way. This is the largest machine which I could induce my kind friends, the firm of Messrs. Clark and Muirhead, to construct for me. I would, were money enough available, apply the principle to coils wound obliquely on the thin rim of a great fly-wheel of a large steam-engine, fixing magnets obliquely to one another on both sides of the rim.

I have so much pecuniary interest in the future of this machine that it would take from the impersonal character of the lecture if I brought it before you too prominently. Its performance may be examined into at the manufactory. If time allowed, I would rather dwell on the enormous social phenomena which are preparing to develop themselves. England is a very rich country. She can afford, even through her Government which dispenses only a small portion of her wealth, to carry out great enterprises at the ends of the earth. By her canals and roads, and then by her railways,

she has made herself comfortable, and has added to her wealth. Adding to her wealth is an accidental effect, perhaps, but adding to the happiness and health of the poorest people in this cradle of the Anglo-Saxon race is certainly the most important work to be effected by the wealth of England. To do this, through the agency of electricity, will not prove a bad financial investment.

Leaving this very large subject, let me speak of a few of the applications of the above principles which have a future before them. The development of the telephone and of telephone exchanges, until every person in London can speak directly with every other Londoner, and, indeed, with every other person in the country; this, as you all know, is quite a settled matter, although, no doubt, there are little difficulties still to be surmounted. At one end of a telephone wire there is a generator, a magneto-electro machine, which receives sound energy, and gives out electricity. At the other end there is a receiver or motor, another such machine, which receives electric energy and gives out sound. We have, in fact, a simple example, and one of the most economical examples I know of, for the transmission of power by means of electricity. Quick speeds caused by vibrations of many hundred times per second, and strong magnetic fields, have produced this wonderful economy, which enables men in Paris to speak with members of their family in Marseilles. Again, the subject of electric railways is a part of the much larger subject which I have already dealt with. I suppose you all know the general principle of electric railways as hitherto constructed. Only that we like to observe large effects produced, the model which is now working before you would give as clear ideas of future constructions of this kind as the Berlin railway, or the one to be exhibited at Paris. [In this experiment a circular railway was worked from a magneto-electric machine driven by hand.] A generator of electricity is driven by a large stationary engine, somewhere in the neighbourhood of the railway. A motor on a carriage receives electric energy by the conducting rails, and converts this into mechanical work to drive the carriage. Even the small experiments of Dr. Siemens show that there can be no doubt that the introduction of electric railways everywhere is merely a question of capital, and the sacrifice of much existing plant. This kind of proof was very much needed by capitalists. But the electrician sees much further; he sees better insulation for the conductor, and application of the above principles to hundreds of miles of rail instead of a thousand yards; he sees, in fact, that the larger the experiment, the greater must be its success. He looks forward to the absence of a vitiated atmosphere in our underground railways. He sees that the weight of rails (for there will be no heavy locomotive in the future; each carriage will have its own driving and braking machinery), and the cost of bridges, and wear and tear of permanent way, may become less than one-quarter of what they are at present; he sees, in fact, all the advantages that will arise, when, instead of making a heavy steam-engine travel backwards and forwards with carriages, the carriages alone travel, and the steam-engine is not near the railway at all. In that case, also, all the energy at present wasted in stopping a train, will simply be given back to the generator.

I have mentioned electric lighting, and telephones, and railways, because I know that many of you must have expected to hear of them, but I mainly wish you to consider these appliances as examples simply of the transmission of power by electrical means. In the same way I might refer to a countless number of other appliances, giving you a mere catalogue of them; but, from the ordinary house-bell to the complicated arrangement by which my brother regulates the weirs on a river to prevent floods; from the time-regulating luxury of certain clockmakers, to the quadruplex telegraphy of Muirhead and Winter, they are simply methods of transmitting energy by electricity, and as such, their economical development depends on the recognition of the above principles. Take, for example, the case of ordinary telegraphy. There can be no doubt that it is absurd to fill large houses with tens of thousands of voltaic cells to work telegraph lines. But it is not sufficient for the Post-office authorities to feel the annoyance, and merely try to replace batteries with such a machine as you see before you—a machine of but one *ohm* resistance, while every mile of telegraph wire may have twenty ohms resistance. I am sure that everybody belonging to the telegraph department will be satisfied with a change that gives them one dynamo machine for all those thousands of sloppy voltaic cells; and there is no longer any excuse for further delay, since Mr. Schwendler has been perfectly successful in working long telegraph lines in India in this very manner.

When we think of electricity as an agent by means of which energy may be transferred and altered, it is natural to ask if, by means of it, energy can be stored up. If we could obtain an efficient method of storing energy, the result would be of very great importance in a variety of ways. Thus, if all the work obtainable from the tide filling and emptying great shallow basins, could be stored up, so that it might be given out steadily, and only at our pleasure; if all the work obtainable from wind-power, which is constantly varying, could likewise be stored up, so as to be readily available, a long-standing difficulty would be got rid of, which has hitherto prevented the working out of large schemes for the utilisation of these sources of natural power. And not only in these large cases, but in a countless number of other ways, is it important to possess means of storing energy. In the manufacture of gunpowder, and in many chemical operations, energy is stored up; but no such method can ever become economical. It has to be remembered, however, that electrical operations may be made as economical as we please; and however insignificant the method may appear to be just now, it may assume great importance in the future, from the fact that, with the exception of the lifting of heavy bodies to higher levels, an electrical method of storage may be made more economical than any other. Now when I charge this Leyden jar (experiment shown) you know that I store electrical energy, and I can use my stored energy at any future time if the insulation of my jar is good. Thus I have converted a small store into heat and light. (Experiment shown.) Again, I can use this store at any time to give itself out at a distant place. This is a very small store.

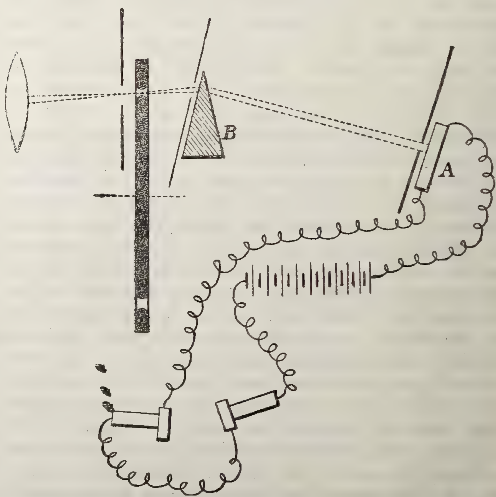
But now observe that my thermopile has been working for nearly an hour, and some time ago it had filled these two test tubes with oxygen and hydrogen. With these two gases I can produce, as you all know, a most intense heat. You all know that this lime light is produced simply through my having such a store in these iron bottles which you see before you. Remember that these gases might be kept stored up for as long as we like, and that if a windmill worked a magneto-electric machine it could produce such a store working now fast, now slow. Well, but I can take this store and convert it again into electricity with very little loss. You will see that it can produce an electric current if we have two similar metal plates in the positions you see them in, and if I connect these metal plates through the galvanometer (experiment shown), you have there evidence of a current, this deflection of the needle of the galvanometer. This current will continue to flow, and the electric energy will continue to be given out until all the store of gas disappears.

Instead of using that weak thermopile, suppose I had used this strong current produced by the outside engine, you see how much more rapidly my store is formed. (Experiment shown, in which the gases rapidly formed were used to produce an oxy-hydrogen lime light.) I grant that the elaboration of this gas battery into a compact generator sufficiently powerful to produce very large effects, is a problem of some expense for future workers; but give it to any electrician, and make it worth his while, and I believe that such a generator might be constructed in a very short time.

To introduce the next part of my subject, let me ask—Can anybody hear the sound made by a puff of air as it passes through the hole in this cardboard disc? (Experiment made.) Nobody heard it, or the difference produced when the air was stopped by the cardboard. But suppose I repeat this operation several hundred times per second, you can all hear the powerful musical note given out. (Experiment.) You see, then, that the rapid recurrence of effects may be very sensible to us, although one such effect may not be sensible. In the same way, if light streamed through one of the holes in this brass disc into your eyes, it would not produce a very striking effect; whereas Professor Tyndall says that when such a disc as this was rotating so as to let the light falling on his eyes be very rapidly intermittent, he experienced the most extraordinary sensations. Again, if I very much alter the magnetic field in this telephone, by bringing a powerful magnet near it, with great care in listening I hear the faintest sigh, due to the diaphragm settling itself into a new position, its vibrations dying away as it does so; and if I brought a small magnet near, I should hear nothing. And yet the change of magnetism which produces the loud telephonic effects which we listen to is almost infinitely smaller. Why is this? It is due to the rapid recurrence of the effects. Now you are all aware of the importance of the telephone as a method of communication; I believe that a much greater importance is in store for it as a laboratory appliance.

Here is a selenium cell through which I can pass a current of electricity from this large battery, which also passes through these two telephones, which I can hold to my ears. When light falls on this selenium its electric resistance is diminished, and a stronger current passes. This is a property discovered by Mr. Willoughby Smith. Now I cannot hear in the telephone any effect produced by letting light suddenly fall on the selenium. The difference of current produced in the very case before you is only one two-thousandth of a weber. But if I rotate this brass disc so as to make the light fall with intermittence several hundreds of times in a second on the selenium, I can distinctly hear a musical sound. This is what Professor Bell has been exhibiting lately, and it constitutes the principle of the photophone. Now to give you an idea of the new ground which the use of the principle of recurrence is opening up in laboratory work, let me speak of an experiment which is now in progress. Professor Bell spoke in his lecture of having tried to stop the intermittent rays of light of this iustrument by a sheet of ebonite like this, but he found that there was still a very faint sound from the telephones. Well, it occurred to Professor Ayrton and myself that if ebonite is transparent to some kind of invisible radiation, then in all probability it is capable of refracting such invisible rays. So we obtained this ebonite lens, and two prisms, and tried. We thought the lens would bring the invisible rays to a focus, but as our lens was not mounted, so that we could move it parallel to itself, and as the rays are, of course, quite invisible, so that our eyes cannot help us to focus the ebonite lens, we did not succeed in this very delicate experiment, which the following experiment, however, shows, must ultimately be successful. Next we placed the cell at A in this diagram (Fig. 7), and found that it gave out no sound, being beyond the range of the beam of intermittent light. We placed the prism in the position B, in which you see it, and, to our great satisfaction, a sound was heard. You must remember that this sound, and any sound obtained from light that had passed through ebonite, was exceedingly feeble. The person who listened was in another room, so as not to be in any way influenced by what he saw, and his pre-

Fig. 7.

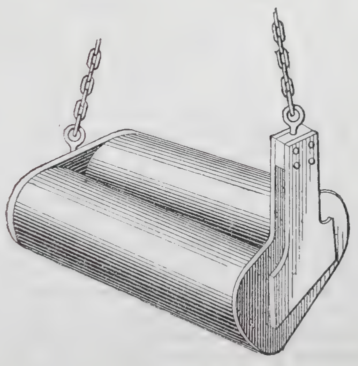


ciseness in detecting sound was determined by another experimenter putting his hand in the beam

of light and taking it away again. So that there could be no doubt as to the origin of the faint sounds heard. Well, the prism caused the light to bend round, and now the question was as to how much bending it produced. We provided two pieces of zinc plate, with slits cut in them. You all understand, I hope, that the most advanced physicists regard a metal as a perfectly opaque body, even to invisible rays, so that rays can only pass through the slit in our zinc. Well, we placed the slit in the zinc within a short distance of the edge of the prism, and found a position in which the rays, passing through the slit, still reached the selenium. The sound was now very faint. Then we searched on the selenium with the edge of our second piece of zinc, to find what region of the cell might be covered without destroying the sound. We found that region, and placed our second slit there. Rays passing through the first slit were now passing through the second slit. If either was changed in position, the sound died away instantaneously. Thus, there could be no doubt of the fact that ebonite refracted that invisible beam, about which nothing else is as yet known. If our slits had been very narrow we could have measured accurately the index of refraction, but with narrow slits the sounds were too faint to be heard in the centre of London; so all that we can say at present is, that ebonite certainly refracts light, and its index of refraction is, speaking quite roughly, 1·7. Now, it is somewhat curious that this was the rough measurement which we made. For Clerk Maxwell's theory, that light is propagated through space like an electro-magnetic disturbance, requires the square of the index of refraction, for light of very low refrangibility to be equal to the electric specific inductive capacity of the substance, and it has long been known that this electric constant for ebonite varies from 2·2 to 3·5 in different specimens. The square of 1·7 is 2·89. Thus, you see that this curious following out of our first idea has led to a further backing up of Clerk Maxwell's electro-magnetic theory of light. This and other investigations which we are now proceeding with, illustrate two important things, namely—the principle of recurrent effects in the use of the telephone, has opened up a new path into unexplored nature; and, secondly, the laboratory worker sees before him a hundred interesting phenomena, which ought to be investigated at once, and which he cannot take up unless he gets more apparatus, more money, and more observing eyes and working hands.

About two years ago, it struck Professor Ayrton and myself, when thinking how very faint musical sounds are heard distinctly from the telephone, in spite of loud noises in the neighbourhood, that there was an application of this principle of recurrent effects of far more practical importance than any other, namely, in the use of musical notes for coast warnings in thick weather.* You will say that fog bells and horns are an old story, and that they have not been particularly successful, but our scheme was of a somewhat different kind. In northern Japan, where fogs are the rule and not the exception, which they are in England, and where changing currents of more than six knots are common off many dangerous parts of the coasts, ship-masters are very much in the habit of using their steam-whistles, listening for the echo from the steep coasts, and judging from the interval of elapsed time what is their distance from the coast, and what is their position. But they find that on many foggy days they can, and on other foggy days they cannot use this method, because they may hear no echo, although quite near the coast. Now, it seems to be forgotten by everybody that there is a medium of communication with a distant ship, namely the water, which is not at all influenced by changes in the weather. At some twenty or thirty feet below the surface there is an almost perfect calm, although there may be large waves at the surface. Suppose a large water-siren like this (experiment shown) is working at as great a depth as is available, off a dangerous coast, the sound it gives out is transmitted so as to be heard at exceedingly great distances by an ear pressed against a strip of wood or metal dipping into the water. If the strip is connected with a much larger wooden or metallic surface in the water the sound is heard much more distinctly. Now, the sides of a ship form a very large collecting surface, and at the distance of several miles from such a water siren as might be constructed, we feel quite sure that, above the noise of engines and flapping sails, above the far more troublesome noise of waves striking the ship's side, the musical note of the distant siren would be heard, giving warning of a dangerous neighbourhood. I have no time now to tell you of the small experiments we have made in this direction. This electric-bell sounds only very faintly when in water, and yet we have been able to hear it at the distance of sixty feet along a trough of water in a place filled with the noise of much heavy machinery. We took this water siren to Hastings for a trial in ordinary boats, but the weather was too rough at

Fig. 8.—Submarine Coast Warning.



An electro-magnet, with vibrating armature, giving out loud musical note.

* Since the reading of this paper, my attention has been drawn to a letter in the *Engineer*, of Jan. 28th, 1876, from Mr. H. T. Humphreys, who there suggests the use of submarine sirens as coast warnings. Since the idea struck Mr. Ayrton and myself, we have been wondering how it escaped attention so long. We now wonder why the lighthouse authorities have made no efforts in the last five years to carry Mr. Humphrey's idea into effect.

the time for boats to go out; and, therefore, the experiment had to be postponed. We have constructed the arrangement shown full size in this diagram, in which currents of electricity are sent from a distance sufficiently rapidly intermittent through this electro-magnet to give the natural period of vibration to this armature when in water (Fig. 8.) Whether this will prove successful or not we do not know, but we feel sure that the idea is to be carried out electrically, the source of sound being a motor worked by a generator on the nearest coast. In considering this problem, you must remember that Messrs. Colladon and Sturm heard distinctly the sound of a bell struck under water at the distance of nearly nine miles, the sound being communicated by the water of Lake Geneva.

Another application of the principle of recurrent effects, which may, indeed, be regarded as the earliest of such applications is this multiple telegraph of Mr. Elisha Gray, which my friend Mr. Graham has been kind enough to put in working order, so that it may be worked from this table to the telephones hanging against that wall. About this telegraph which allows a great number of messages to be sent through an ordinary telegraph wire at the same time, Sir William Thomson wrote to me in terms of high eulogium when he first examined it at Philadelphia. At present I believe that the quadruplex system is more favourably looked upon because it has succeeded better in practice, but I am inclined to think that in the distant future it may possibly have enormous development.

In this paper I wish I could bring in, as illustrations of the few great principles which are really the important factors in the future development of electrical appliances, the microphone and all the instruments which have been derived from it, but even to refer to them would take far too much time. I would end by speaking of two appliances which are of quite a different species, namely, Mr. Edward Bright's method of de-electrifying woollen yarn, and of a contrivance for seeing by electricity. In the manufacture, the woollen yarn becomes electrified by friction, and has hitherto lost its electricity very slowly, requiring to be stored for many months in damp cellars before it got rid of its electricity. Until lately, nobody seems to have suspected that it was electricity which caused the fibres to stick out on all sides of the yarn instead of staying in an interlaced condition. It was found to occur most in dry weather, and was vaguely put down by Englishmen to "the weather." So very annoying was this in a dry climate, that although Bradford men and Bradford machines were taken to America, only two months in the year could really be devoted to the manufacture. Now, we have here some woolstaple in the air which is being electrified by this plate machine. You see how the fibres repel one another and remain in this state. You observe, however, that these other fibres we try vainly to electrify because they are in a partial vacuum, and electricity escapes from them as rapidly as it is formed. I will allow air to enter this air-pump receiver, and now, when the machine is worked, you see—(Experiment shown)—that these fibres retain their electricity. The principle that a partial vacuum is very conductive has long been known to electricians, but the remarkable saving in woollen manufacture, effected by applying a knowledge of the principle, was left for Mr. Bright. Mr. Bright's plan of operations is to have chambers where partial vacua may be produced. He wheels large trucks of electrified bobbins of yarn into these chambers, and takes them out very soon, unelectrified, thus performing, in a few minutes, an operation that used to be badly performed, in a costly manner, in half a year. Can we doubt that, when boys obtain, in all elementary schools, a little knowledge of electricity, there will be rapid additions to the number of electrical appliances?

And now let me come to the last of the developments of electrical appliances, still perhaps somewhat in the future. A picture in *Punch* of an aged couple at home seeing on their drawing-room wall an image of their children playing lawn-tennis out in India, and of their conversing with some of them by telephone, first led Mr. Ayrton and myself to think of this matter. We showed that it was feasible, in a letter to *Nature*, and in the *Times* about a year ago. The feasibility of the method described by us was doubted, and we therefore proved it at a meeting of the Physical Society four weeks ago. I mean to put it before you in a slightly different form. Suppose that place is York, and this is London. I have a little selenium cell at York on a certain part of this picture, and at London I can throw at a corresponding place on this screen a square of light; and suppose that the illumination of this square is governed by a little movable shutter which is attached to the needle of a galvanometer. Now when light falls on the selenium at York, an immediate change occurs in it, so that more current flows to London, and this opens the shutter. The London square is then bright, when the York selenium is in bright illumination. When the York selenium is in shade or darkness, you see that the London square is in corresponding shade or darkness. (Experiment shown.) Now suppose that we form an image of this girl with her skipping rope at York, and cause a selenium cell at York to travel across her image, and suppose that this mirror at London moves so as to cause the illumination which passes the shutter to traverse this London screen isochronously—an operation performed in several telegraph instruments. Then whenever this cell reaches a dark, or shady, or bright place in the image at York, there will be darkness, or shade, or brightness at the corresponding place in London. And now suppose that this motion is effected rapidly enough, you are all aware that if the shutter is only quick enough in its answering motions, the image of the part of the screen at York traversed by the cell will be faithfully reproduced, and will remain on the retina at London as a distinct picture in black, and grey, and white, just like a photograph. With then, perhaps, forty such cells as this all moving in the way spoken of, or a smaller number rotating on a radial arm, it would actually be possible to show at London, not merely an image of a girl at York, but an image of a girl skipping. You will, perhaps, understand better this principle from the model. Here is a path of black and white spaces at York, over which this selenium cell be made to travel. We have continued the images to the paper above, simply to let you know when the cell is in the image of a dark place, and when it is in the image

Fig. 9.

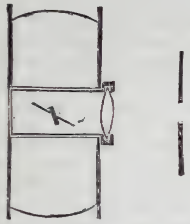
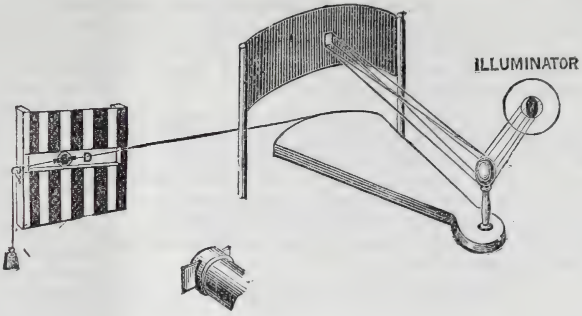


Fig. 10.



of a bright place, so that you may be able to say whether there is a faithful reproduction at London. These two frames are really tied together by this long string to make them move isochronously. In practice, I need hardly say that this function will be performed in another but quite as feasible a manner.

The cell at York is in a black part of the picture; you observe no light on that part of the screen in London. The cell at York is in a bright part of the picture; the corresponding part of the screen at London is bright. And so we find that, as the cell goes successively through dark and bright places, so the corresponding parts of the screen at London are made dark and bright. (Experiment shown.) Our shutter is not yet sufficiently dead-beat for us to make this motion rapidly.*

I had hoped to be able to show you to-night the development of this method, by using what we have called the Japanese-mirror principle. We have shown† that the most minute effects on the backs of metal mirrors, effects quite invisible when examining the polished surface of the mirror, are very visible in the reflection of a divergent beam of light. Such effects, we believe, we can produce by electro-magnets arranged radially behind a circular mirror and rotating with it. This radial arrangement of magnets will move synchronously with a radial arrangement of corresponding cells. The principle, however, is exactly the same as that shown by this model, only we know that the change of curvature at a point in a mirror will obey changes of magnetic effects more rapidly than this shutter does.

I had hoped to be able to present to you the scheme which Mr. Shelford Bidwell has proved to be feasible, of reproducing in shaded lines on paper, by electro-chemical decomposition, a picture of a distant stationary object. I understand, however, that Mr. Bidwell has been asked to read a paper here, when he will exhibit the model he has made.

In my paper read here a year ago it was the importance of giving artisans facilities for obtaining practically exact knowledge in science that I especially laid stress on. To-night I have desired, first, to show what benefits our country would receive from an exact knowledge of electrical magnitudes, and of the fundamental laws of electricity being more widely disseminated, and, second, how the principle of recurrent effects may be employed to assist our senses.

* After the reading of the paper, it was found that even with the shutter it was nearly possible to make the motion fast enough for the retention by the retina of a complete image of the path traversed.

† See Proceedings of Royal Society, No. 191, p. 127, 1878.

DISCUSSION.

The Chairman said, in the usual course of things he should have liked to invite discussion on some of the many points referred to in this most interesting paper, but it was now so late, that although it would be permissible for any one to make an inquiry, it would be impossible to have a full discussion. He, himself, should like to ask a question on one point, which was this—Did he rightly understand Professor Perry that the whole power of the Falls of Niagara might, under some circumstances, be transmitted to New York through a single telegraph wire? It appeared to him that the enormous difference of potential at the two ends of the wire, and the large quantity of electricity passing, would cause more than sufficient heat to fuse the wire.

Professor Perry said his notion was what had been stated, and that he believed was the logical mathematical deduction from the fundamental laws of electricity; and in this Professor Ayrton agreed with him. It was the current of electricity passing through the wire which produced the heat, and if only a very small quantity passed through it could not be fused. Now the quantity of electricity was only one factor, the energy transmitted was equal to the potential $\times$ quantity. Suppose the one were 1,000,000, and the other $1{,}000{,}000 \times 1 = 1{,}000{,}000$; if the one became $\frac{1}{2}$ and the other 2,000,000, the product was equally 1,000,000; and if one factor became $\frac{1}{1000000}$, and the other 1,000,000,000,000, the result was still 1,000,000; the product was always the same, and the smaller factor might be made as small as you pleased. That was their contention, and though it was very probable they might never be able to produce practically the perfect insulation required, he believed the theoretical deduction was sound.

Professor Ayrton said the lecturer referred to the difference of potential, not at the two ends of the wire which transmitted the power, because, of course, where there was much difference of potential at the two ends of the wire, there would be a tolerably large current passing, but the difference of potential between the wire at each end and the earth. The difference of potential between the two ends of the wire would be exceedingly small, and, therefore, the current flowing through would be exceedingly small; but the difference of potential between any parts of the wire and the earth would be extremely large, so that much work could be

put in at the generating place, viz., Niagara, and much work would come out at the motor place, viz., New York, but the current flowing through the wire, which depended upon the difference of potential between the two ends, would be exceedingly small, because, though each would be very high, they would be nearly equal to one another. Consequently the waste of energy in electric friction would be small.

The Chairman said he thought this explanation had thrown considerable light on the point referred to, which was one of great practical importance. He begged to move a hearty vote of thanks to Professor Perry for his very interesting and instructive lecture, and for the experiments which had accompanied it.

The vote of thanks was carried unanimously, and the proceedings terminated.

MISCELLANEOUS.

FIRES IN THEATRES.

The following remarks on the necessary arrangements for public protection from fires and panics at theatres and other public establishments, are taken from the report of Mr. Edwin Chadwick, C.B., to the Committee of the Society of Arts on the Prevention of Fires and on the Water Supply of the Metropolis, dated July, 1877, and are re-published at his request:—

"It follows from the information on the prevention of fires and panics at theatres, which was received by our Committee, and on which we made a special report, and, it may be added, from the more full evidence subsequently received by the Select Committee of the House of Commons, that securities should be taken, by a public authority, for protection against these calamities before such edifices are constructed or opened for the reception of the public. All large places of public entertainment and large hotels, many stories high, and for the accommodation of several hundred persons, ought, it is contended, to be included in the like provisions for protection. It was suggested by witnesses before the Select Committee, that an independent special fire authority should be appointed for the purpose. But this proposal is objectionable in principle, as involving either a separate and weak establishment, or, if it be a strong one, an excessively expensive one. On consideration, it will be seen that the most eligible course will be to charge such duty upon the fire service of the general police force, because, of necessity, it must have the largest amount of experience for its guidance, and the greatest executive force to see the constant application of that experience in any provision for security that science and practice may suggest. At present the special fire service of the metropolitan police has a greater amouut of practical experience in fire prevention than any other force in the country, as stated in the millions of property at the Woolwich Arsenal and the dockyards throughout the country. But for a high order of skill, and a vigilant patrolling force, combined with a force of engine power, Portsmouth, and other dockyards, would have been repeatedly destroyed. Under the existing arrangements, such provisions as there are for the prevention of fires in the metropolis fall to the district surveyors under the Board of Works—architects in private practice, but not of the highest practice, but practice much needing amendment, as the frequent destruction of property in houses of their construction shows. The work of fire prevention increases in speciality with the magnitude of the building and the numbers of the people to be accommodated and protected, and the speciality of service applicable to the purpose rises above the highest architectural practice. The care against fire necessarily accompanies the elaborate provisions now required in such edifices for warming, for lighting, and ventilation. The application of science for the purpose, to the Houses of Parliament, by such scientists as the late Dr. Reed, Sir Goldsworthy Gurney, and now to Dr. Percy. In Paris it was led by the late Leon du Voir le Blanc, and now by General Morin, of the Institute, and Mons. Charles Joly. The new great theatres are becoming elaborations of new practical science. The new Grand Opera at Vienna has some twenty miles of pipe to be regulated for the distribution of warmth, and between five and six thousand jets of gas to be regulated for its lighting, with electric communication from a central office to collect thermometrical conditions of all parts of the theatre for their regulation. The provisions against fire, in progress when I visited it, were correspondingly elaborate. These developments of science, in the larger constructions, are applicable in their degree to lesser buildings. Provision might, it should be submitted, be most advantageously made for them in connection with the present high practice of the general police service, which might conveniently have such consultative scientific aid as is now provided for the Houses of Parliament for the guidance of the large executive service of rank and file available for the public protection."

PRESSURE OF WIND.

Mr. C. Shaler Smith has lately communicated a paper to the American Society of Civil Engineers containing the results of many years' observations of wind-pressure on bridges, of which the following is an abstract:—He personally visited the tracks of destructive storms as soon as possible after their occurrence, for the purpose of determining the maximum force and width of the path in each case. The most violent on his records are as follows:—1. East St. Louis, 1871—Locomotive overturned; maximum force required, 93 lbs. per square foot. 2. St. Charles, 1877—Gaol destroyed; force required, 84·3 lbs. per square foot. 3. Marshfield, Mo., 1880—Brick mansion-house levelled; force required, 58 lbs. per square foot. 4. Havre de Grace, Md., 1866—Ten spans wooden Howe truss bridge, 250 feet each, blown over; force required, 27 lbs. per square foot. 5. Decatur, Alabama, 1870—Two spans of Combination Triangular truss blown over; force required, 26 lbs. per square foot. 6. Meredosia, Ill., 1880—One span wooden Howe truss, 150 feet long, overturned; force, 24 lbs. per foot. 7. Omaha, Nebraska, 1877—Two spans iron Post truss, 250 feet each, blown down; force required, $18\frac{7}{10}$ lbs. per square foot. Also, sundry cases of train derailment caused by wind, the maximum force required being $30\frac{1}{2}$ lbs. per square foot.

The author observed that in each of the foregoing cases we had given what appeared to be the maximum effort of the wind and the lowest pressure required to produce the observed result, so that it is not unlikely that the real force of the wind in each example was greater than that given. Some of the tornadoes were very destructive — the Marshfield one, for instance, having cut a swath 46 miles long and 1,800 feet wide, and killed and wounded over 250 people. Mr. Shaler Smith gave the following reasons for considering 30 lbs. per square foot sufficient for a working specification, although the instances given above show much higher pressures. First, he doubted if a direct wind or gale ever exceeds 30 lbs. per foot; whirlwinds do exceed it, but the width of the pathway of maximum effort in these is usually very narrow, although the general direction is so erratic that the appearance of the *débris* is generally such as to produce the impression that the vortex was much larger than was really the case. With the exception

of the Marshfield tornado, he had yet to find a storm swath where the width of pathway, wherein the force exceeded 30 lbs. per square foot, was more than 60 feet wide. The St. Charles tornado is a case in point. This whirlwind cut a swath about 1,000 feet wide for fourteen miles, and destroyed over three hundred houses, exerting a force of over 84 lbs. per square foot at its point of maximum effort. It crossed the middle span of the St. Charles bridge nearly at right angles, and developed a pressure of $52\frac{1}{10}$ lbs. per sqnare foot in picking up and crushing a barrel of tar, which stood on the bridge in the path of the vortex. The width of the vortex was distinctly marked on the span by the circle in which the tar was spun around, the wreckage left upon it, and the points at which it ceased to destroy the flooring. This width was thus shown to be slightly over 60 feet, and, guided by this, Mr. Smith was subsequently enabled to locate the path travelled by the central vortex throughout the entire length of the storm swath. The bridge itself was uninjured, although it was only proportioned to withstand 30 lbs. per square foot, with a strain of 20,000 lbs. per square inch on the braces. This span was 320 feet long, 30 feet in depth, and the top chord was 120 feet above the water. He considers it very unlikely that a bridge of over 200 feet span will ever be exposed to a wind force of more than 30 lbs. per square foot, acting in the same direction over its entire length. Next, a fully loaded passenger train and the heaviest possible freight train will leave the track at the respective pressures of $31\frac{1}{4}$ and $56\frac{1}{2}$ lbs. per square foot. If the braces are proportioned at 15,000 lbs. per square inch, with a wind pressure of 30 lbs. per square foot, they will still be within their limit of elasticity at the moment when the train is blown from the track in either case. Destruction of the span will then taken place, if at all, from the effect of derailment; to resist which greater strength in the wind bracing will be of no value. Next, if there is no tension in the pier columns until 30 lbs. wind pressure is reached, and these columns are properly spliced and anchored, as per specifications, there will be an ample margin of tensile strength in any case where this pressure may be exceededed. Last, in view of the comparative rarity of these extreme strains and the consequent slight fatigue to which the iron is exposed, the high stresses imposed on the wind bracing are perfectly legitimate.

THE WAX PALM IN PERNAMBUCO.

The Camanba palm (*Copernicia chifera*) seems to be a much more important plant in some parts of Brazil than is generally supposed. In Pernambuco the plant is very abundant, and the uses to which it is put very numerous. The wood, for instance, is used for roofing, both as beams or rafters, and as laths upon which to support the tiles; the fruits are used for feeding cattle, and the leaves are used for making hats and mats. A valuable medicine is obtained from the roots, which has recently been brought to notice in this country. From the shoots or leaves a wax is obtained; for this purpose they are cut before they unfold, dried in the sun, powdered and boiled, the wax rising to the surface of the water. This wax, it is stated, is not produced in anything like the quantity that it might be. It is shown, in a recent report of her Majesty's Consul at Pernambuco, that the export of this wax during 1875-76 amounted to 18,668 kilos., valued at £758; in 1876-77 to 171,980 kilos., valued at £6,957; in 1877-78 it fell to 89,482 kilos., of the value of £3,168; and in 1878-79 to 1,542 kilos., valued at only £61. By far the largest portion of this wax finds its way to this country. It is shown that the decrease during the last year was due to the famine and drought which so severely crippled all industry in the province. It is not a little remarkable that, at a time when roasted date stones are proposed as a substitute for coffee, we should also learn that the stones or seeds of the Camanba palm, when roasted, are used in Pernambuco as coffee.

THE NEW EDDYSTONE LIGHTHOUSE.

The following particulars respecting the progress of the works at the new Eddystone Lighthouse are given by the *Architect*:—

"The masonry up to the fifty-second course, which is 80 feet above low-water mark, has been completed. It is now on a level with the light of the old tower; thus the new tower already intercepts the light from the old tower over a very perceptible area, viz., 12 degrees near the reef. This would soon be passed over by a ship, but at five miles distance there would be a mile of darkness on a true south-west course. It was intended in the original specifications to provide for this interception by placing a second light in the new tower at the same level as that in the old tower, so screened as to be visible only within the limit of the dark arc. There was also to have been a temporary bridge from one tower to the other, so that the second staff of light-keepers might have communication between the two towers. This, however, is not to be carried out, and the Trinity Corporation have given public notice to mariners that there is such a dark arc, and the cause of it. The fifty-first course, which was laid a few days ago, is a floor course, and completes the fourth apartment above the well. The room just completed is the crane-room, and is provided with two doors besides a window, one facing south and the other north, so that stores may be taken in from either one side or the other, according to the state of the weather. The three rooms below this will be occupied as oil and general store rooms. The room immediately above the crane-room was to have been occupied by the white fixed subsidiary light, which is to cover the reef of rocks known as the Hand Deeps. The rocks bear from the Eddystone Lighthouse three and a quarter miles in a direct line between it and Lool Island. At low water there is a depth of four fathoms of water upon them. Although this would be ample for ordinary craft in fair weather, yet in rough weather it may go ill with even a small vessel in the trough of a sea, much less one of a larger class, or, perchance, an ironclad. This subsidiary light will only be seen within the area above named, and when in the vicinity of danger. It is now intended that this subsidiary light shall be placed a room higher, so changing places with the living room. These modifications, together with the preparation of the light itself, are being carried on in the yard at Oreston, and afford occupation for the men when they are not able to work at the rock. In external appearance the new tower will be a complete alteration from the old both as to height and colour, being nearly as double as high, and of uniform granite, like the breakwater lighthouse. The light itself is to be a modification of the plan recommended by Sir William Thomson. Instead of a fixed white light, as at present, it will be oscillating. The light will be a powerful white double-flashing half-minute light, showing two successive flashes of about $2\frac{1}{2}$ seconds' duration, divided by an eclipse of about four seconds, the second flash being followed by an eclipse of about 21 seconds. The light will be visible all round the horizon, but from its more elevated position it will be seen in clear weather $17\frac{1}{2}$ miles, and its field of visibility will overlap that of the Lizard, instead of there being, as now, eight miles of darkness. Out of the 2,200 stones, of which the tower will consist, over 1,800 are already in position. At the present rate of progress, therefore, it is probable that next autumn's excursionists will witness the completion

of the tower, and mariners are informed by public notice that the new tower will be ready for the exhibition of a light early next March."

COCA (ERYTHROXYLON COCA).

In Mr. Markham's "Peruvian Barks," recently published, he has given the results of his own observations, and collated that of other travellers, respecting this substance, and to this account we are chiefly indebted for the following facts:—

"Coca," the "beloved narcotic of the Peruvian Indian," was first named botanically through the labours of Joseph de Jussieu. The history of this noted botanist is a melancholy one. He left France in 1735, in the ever memorable expedition of La Condamine, and after M. La Condamine left South America, M. Jussieu continued his botanical researches, making numerous journeys on foot, notably those to the Cinchona regions. The results of fifteen years labours were contained in certain cases of dried plants, &c., and a native servant at Buenos Ayres, thinking these cases contained money, stole them, and this loss had such an effect on poor Jussieu that he returned to France in 1771 deprived of reason.

The coca is the great source of comfort and enjoyment to the Peruvian Indian. It is to him what the kava-kava is to the South Sea Islander, the betel to the Hindu and Malay, and tobacco to the rest of mankind, but with this difference it produces invigorating effects. The Peruvian Indian looks upon coca with veneration. In the palmy days of the Uncas or Yncas, coca was sacrificed to the sun, the high priest or Huillac Umu chewed it during the ceremony, and before the arrival of the Spaniards, coca was used in lieu of money. After the Spanish Conquest, much was done to prescribe its use, because as a Council of Bishops held in 1569, said it was a "useless and pernicious leaf, and on account of the belief stated to be entertained by the Indians, that the habit of chewing coca gave them strength, which is an illusion of the devil." Coca, indeed, from its popularity, being used by about eight millions of people, has always had a great commercial importance, and one Viceroy, Don Francisco Toledo, issued no less than seventy ordinances concerning coca in the space of four years (1570-1574).

The coca plant is a shrub of four to six feet high, with straight and alternate branches and leaves like those of the tea plant, and is cultivated at elevations of from 5,000 to 6,000 feet above the level of the sea in the warm valleys of the eastern slopes of the Andes. Here the only alternations of climate is from wet to dry, frost is unknown, and it rains more or less every month of the year. The seeds are sown on the surface of the soil as soon as the rainy season commences, and begin to sprout in a fortnight, being carefully watered, and protected from the sun by a thatched roof. The following year the seedlings are transplanted in a soil carefully broken up and freed from weeds. The ancient custom was to raise the plants in terraces on the hill sides, but now plantations on the level ground are resorted to, although Indians aver that plants raised under the former conditions yield a much superior quality of leaf. At the end of 18 months the first harvest is ready, and the picking of the leaves, performed by women and children, is very carefully proceeded with, so as not to injure the young and still tender shoots. As soon as one crop of leaves is removed, if well watered, and the ground carefully weeded, another crop is ready in about 40 days. A plant continues to yield for about 40 years, and Dr. Poeppig gives the profit of a coca plantation as about 45 per cent. Each picker carries a piece of cloth in which the leaves, plucked one by one, are placed. These leaves are then taken to the drying yard, formed of slate flags. Here the leaves are spread out in thin layers, and carefully dried in the sun. Too much exposure to the sun spoils the flavour of the leaf, and if heaped too much together, the leaves ferment and become fœtid. As soon as dried, the leaves are packed in bags made of banana leaves, with an outside covering of cloth, or packed tightly in larger parcels of about 50 lbs. each.

In the Sandia district of Caravaya, two varieties of coca are recognised, the Ypara and the Hatun Yunca, the latter having a larger leaf than the former.

In Bolivia, coca is treated as a Government monopoly, and the right is generally farmed out. In 1850, coca brought into that country's exchequer a sum of 200,000 dollars. The whole yield of coca in South America is estimated at thirty millions of pounds. Coca soon deteriorates in keeping, and Indians treat it as valueless if kept longer than seven months.

Such is the faith in coca, that it is believed if a dying man can but taste a coca leaf when placed on his tongue, his future bliss is assured. No Indian is without his *cuspa* or coca bag made of llama cloth, and three times a day, sitting down, he takes leaf by leaf and rolls them up in his mouth till he forms a ball. Then applying a small quantity of powder consisting of carbonate of potash, made by burning the stalks of the quinoa plant, mixed with lime and water, he goes on his way rejoicing. The use of coca is widely spread. The shepherd on the cold slopes of the Andes has but this and a little maize as his sole nourishment, and the runner messenger looks to it as his solace and support. As to the properties of coca, it seems very evident that it allows of a greater amount of fatigue, with a lesser amount of nourishment, and prevents difficulty of respiration in ascending steep mountain slopes. It has an agreeable and aromatic taste, accompanied by a slight irritation, which excites the flow of the saliva. When made into a tea, in taste it is like that of green tea, and effectually prevents drowsiness. Applied externally as a poultice, it moderates rheumatic pains, brought on by exposure to cold and wet, and also cures headache.

Mr. Markham chewed coca leaf very frequently, and states that he found it to produce an agreeable soothing feeling, that he could endure longer abstinence from food with less inconvenience, and that when using it, he could ascend precipitous mountain sides with a feeling of lightness and elasticity, and without losing breath. He also considers it the least injurious of all other like substances, even when taken in excess, and at the same time the most soothing and invigorating.

NOTES ON BOOKS.

An Agricultural Class-Book, for the use of Schools in South India. By William R. Robertson. Madras, 1880.

The author, who is the Superintendent of Government Farms in the Presidency of Madras, has here produced a book, which is intended not only to enable boys at school to qualify themselves for the Agricultural portion of the Upper Primary and Middle School Examinations, but also to give information to those engaged in agricultural pursuits. The subjects dealt with are soils, the preparation of land for cultivation, tillage implements, and tillage operations, manures, irrigation, &c., farm crops, and farm stock. The author points out how much of the suffering in South India from scarcity and famine is due to bad farming, and what need there is for superseding the tillage implements now in use, by improved labour-saving tools.

Plumbing; a Text-book to the Practice of the Art or Craft of the Plumber, with supplementary chapters upon House Drainage, embodying the latest improvements. By William Paton Buchan. Second edition. London: Crosby Lockwood and Co., 1880.

The first edition of this little book was published in 1876, with the object of affording a handy text-book for the apprentice plumber, but the present one has been enlarged somewhat, in order to make it useful to a wider public. The volume is divided into thirty-one chapters on the different subjects connected with the plumber's work. The roof, with its gutters and ridges, is first described, then comes the arrangement of the pipes, the water-closets, the baths, and the cisterns; the more general questions of water supply are then treated, and the whole is completed with remarks on disinfectants, house and general drainage. The author points out how important it is that the occupant of a house should understand the ramifications of pipes, which, if badly planned, may expose him to such baneful influences. He writes, "The present is the era and grand opportunity of plumbing, and in order to bring it to perfection, both the architect and the plumber must work in harmony, and together do whatever in them lies to produce such a result as will be both creditable to them, and a blessing to the community at large."

GENERAL NOTES.

Institution of Naval Architects.—The meetings of the Institution were held in the Rooms of the Society of Arts, on Wednesday, 6th inst., Thursday, 7th inst., and Friday, 8th inst.

Swan's Light in Coal Mines.—The Swan electric light is, says the *Electrician*, to be "laid on" to Mr. John Watson's Earnock Colliery, Motherwell, and will extend to the pit bottom, the roadways, the station where the underground engine is placed, and possibly the miners' working places.

Electric Light at the Cannon-street Station.—The electric light was used for the first time at the Cannon-street Station on the evening of the 31st ult. The arrangements there consist of Gramme machines and Brockie arc lamps, and the work has been carried out by the British Electric Light Company. Eight powerful lights of 6,000 candles each are suspended from the roof of the station at a height of about forty feet from the platforms, and there are two lights outside the station. There are two circuits for the ten lights, five upon each, and the current for each circuit is produced by one of the large new type of Gramme machines recently introduced by the British Electric Light Company, which work a number of arc lights in series.

Compressed-air Clocks.—A Bill is now before Parliament to give London the benefit of the system of compressed-air clocks, which has been extensively established in Paris. The compressed-air clocks consist of a new and simple construction of the works of the ordinary timepiece, by which all the clocks of any city or town, however much separated and distant from each other, can be governed and wound up and regulated by means of a pneumatic air current and connecting mechanism that secures their regular going and their constant synchronisation. The movement can be applied to all existing clocks or timepieces, wherever placed, and there may be either one central motor or several, according to the area of each municipality. If the system were adopted in London and the environs, as proposed by the Bill already referred to, which has the consent and sanction of the City authorities and the Metropolitan Board of Works, the result would be that every clock embraced within the system, no matter where situated, would always indicate precisely the same time of the day or night. The number of stations proposed for the metropolis by the promoters of the Bill now before Parliament is ten. The maximum charge for public clocks is not to exceed 12s. 6d. per annum.

Plant Labels.—Mr. W. Ingram, the gardener of the Duke of Rutland, writes to the *Gardeners' Chronicle* on this subject:—"I hope the very liberal prize offered by Mr. Wilson for a good plant label will stimulate the inventive faculties of gardeners and others, and that we shall at length secure something on which to register the names of plants prominently and distinctly, and thus be saved from the annoyance of obliterated names that has too often followed from the use of the old easily made and quickly perishing label of wood. As our plant collections increase—and they are increasing rapidly—we feel the want of a fresh label more and more, and I trust that Mr. Wilson's example will be followed by others, and a second and third prize offered for meritorious inventions in plant labels. I have tried many kinds, and have suffered the disappointment that has doubtless attended the efforts of the donor of the prize in his search for a permanent and readily-made label. Wood, paint, and pencil must be abjured for all but temporary purposes. Zinc and indelible ink, which seemed to offer some advantages, have disappointed me. Terra-cotta has crumbled under the powers of frost and wet; even iron corrodes, and, good as it is for some purposes, cannot readily be made use of. We want the medium that offers the facilities given by wood, paint, and pencil, and yet gives the durability of a record inscribed on iron—something that can be quickly fashioned and inscribed, and when done will remain impervious to the action of weather—that will bear rough treatment—that a foot cannot crush, nor the wind nor frost remove, and, with all this, is not obtrusively large—no more conspicuous than the plant it names. Then we want distinctive labels for the various cultivated plants, small and neat for pot plants, strong for shrubs and herbaceous plants, plain and easily read, and readily affixed for fruit trees; and one prize will scarcely include all these. Surely the authorities of botanic gardens might co-operate with Mr. G. F. Wilson in his laudable endeavour to secure a good plant label."

Seaweed Jelly.—The seaweed, *Arachnoidiscus japonicus*, which is used by the Japanese and Chinese to pack porcelain and other articles for exportation, is said, by the *Journal of Applied Science*, to be made use of in France for the purpose of making a spurious fruit jelly. When placed in a tumbler of water, it absorbs the water in a few minutes; then a number of shoots grow, and constitute a jelly nearly as transparent as the water from which it is made. The jelly is easily sweetened with glucose, and cochineal or other colouring matter is added with equal facility to imitate the colour of the fruit. The perfume and the taste were the only real difficulties that remained to be overcome. After considerable study, it was discovered that, by using a mixture of certain ethers with tartaric acid, glycerine, &c., a perfect imitation of the odour of raspberries was produced. By putting a little of this essence to the seaweed which has been allowed to develop itself in water, a substance is obtained which has the consistency of fruit jelly, though no fruit has been used, which is sweet, though no sugar has been employed, and which has the colour and fragrance of raspberries, though altogether destitute of that fruit. When this ceases to please, another very good fruit flavour is produced by treating castor oil with nitric acid. The jelly still retains a little of the fibrous nature of the plant, and has a tendency to split and fall to pieces, instead of forming adhesive lumps. Examined by the microscope, it has no resemblance to the jelly made from fruit. Then, as the jelly must be coloured, it is easy enough to discover the presence of an artificial dye. Without resorting to the laboratory, it suffices to dissolve a little of the suspected jelly in some tepid water, and dip a white silk ribbon in the solution. If it is a natural jelly, the ribbon will only be a little soiled; but if the jelly has been artificially coloured, the ribbon will also be coloured.

Purifying and Bleaching Sponges.—M. Blondeau gives the following receipt:—The sponges are first washed in tepid water, and then in a solution of hydrochloric acid (5 cubic centimètres = 0·3 cubic inches, to 1 litre = $1\frac{3}{4}$ pint), which frees the pores from carbonate of lime. To bleach them, they are immersed, for 24 hours, in a solution composed of five parts of hydrochloric acid to 100 of water, with the addition of six pints of hyposulphate of soda. In this way sponges may be bleached much more effectually and rapidly than with sulphurous acid.

New Application of the Sub-products of Coal-tar.—Mr. Sanders, of St. Petersburg, has succeeded in producing from the heavy oils of coal-tar, a new substance which, in

many cases, takes the place of india-rubber with advantage. It is prepared in the following manner. A given weight of a mixture in equal parts of wood oil and coal-tar oil, or of coal-tar and hemp oil, is heated for several hours, at a temperature of about 318° Fahr., so as to disengage the injurious substances and increase the viscosity of the mass, until it may be drawn out in threads. A second quantity, equal to the former, of linseed oil, preferably thickened by boiling, is now added, and also from one-twentieth to one-tenth per cent. of ozokerit with a little spermaceti. In the meanwhile, the mass is kept at a uniformly high temperature for some hours, when from one-fifth to one-half part of sulphur per cent. is added, after which the product is moulded or otherwise worked in the same manner as india-rubber. The proportions of the three oils named above may be varied so as to obtain a harder or a more elastic substance, as may be required. The product is elastic and tenacious, standing the weather better than india-rubber, and is not deteriorated by great pressure or a high temperature. It is said to be specially suitable for the insulation of telegraph wires, and may be employed alone or mixed with india-rubber or similar resinous substances.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

April 27.—"Five Years' Experience of the Working of the Trade Marks' Registration Acts." By Edmund Johnson.

May 4.—"Buying and Selling; its Nature and its Tools." By Professor Bonamy Price, M.A. Lord Alfred S. Churchill will preside.

May 11.—"The Manufacture of Glass for Decorative Purposes." By H. J. Powell (Whitefriars Glass Works). William Spottiswoode, LL.D., P.R.S., will preside.

May 18.—"The Electrical Railway, and the Transmission of Power by Electricity." By Alexander Siemens. Dr. Siemens, F.R.S., will preside.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

May 10.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

April 28.—"Impurities in Water, and their Influence upon its Domestic Utility." By G. Stillingfleet Johnson, F.C.S. Allen Thomson, M.D., F.R.S., will preside.

May 12.—"Recent Progress in the Manufacture and Applications of Steel." By Prof. A. K. Huntington.

May 26.—"Telegraphic Photography." By Shelford Bidwell. Prof. W. G. Adams, F.R.S., will preside.

Indian Section.

Friday evenings, at eight o'clock:—

April 29.—"The Building Arts of India." By General Maclagan. Andrew Cassels, Member of the Indian Council, will preside.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Four Lectures.

Syllabus of the Course.

Lecture III.—May 2.

Fringes. Twisted thread-work in England in the 15th century. Early designs for plaited and twisted threads. Italian, Flemish, French, and English pillow lace. Laces of primitive design.

Lecture IV.—May 9.

Resumé as to styles of design in hand-made lace. Traditional patterns. Sketch of the development of inventions for knitting and weaving threads to imitate lace. Differences between machine and hand-made laces. Modern hand-made laces at Burano, Bruges, Honiton, &c.

This course will be illustrated by specimens of lace. Diagrams and photographs enlarged will be shown by means of the lantern and oxyhydrogen light.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures. May 16, 23, 30.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 18th...Asiatic, 22, Albemarle-street, W., 3 p.m.

Tuesday, April 19th...Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Wednesday, April 20th...Institute of Bankers (in the Theatre of the London Institution, Finsbury-circus, E.C.), 6 p.m. Mr. John Smith, "The Government Bankruptcy Bill."
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Dr. Wladimir Köppen, "The Frequency and Duration of Rain." 2. Mr. G. M. Whipple, "Results of Experiments made at the Kew Observatory with Bogen's and George's Barometers." 3. Mr. G. M. Whipple, "On a Discussion of Mr. Eaton's Table of the Barometric Height at London, with regard to Periodicity."
Archæological Association, 32, Sackville-street, W., 8 p.m. Mr. H. Syer Cuming, "Seals of the Knights Templars."

Thursday, April 21st...Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Reading and discussion of following papers:—1. M. Le Baron Clauzel, "Rivetting, with Special Reference to Ship-work." 2. Prof. A. B. W. Kennedy, "Results of Experiments on Rivetted Joints, made for the Institution of Mechanical Engineers." 3. Mr. W. W. Beaumont, "Thrashing Machinery." 4. Mr. J. J. Tylor, "Meters for Registering Small Flows of Water." 5. Mr. A. A. Langley, "The Bazin System of Dredging."
Linnean, Burlington-house, W., 8 p.m. 1. Prof. Bayley Balfour, "New Genera of Plants from Socotra." 2. Mr. Edgar A. Smith, "The Fresh Water Shells of Australia." 3. Mr. B. Daydon Jackson, "Note on *Hibiscus palustris* (Linn.) and certain Allied Species." 4. Dr. W. A. Herdman, "Individual Variation in the Branchial Sac of Simple Ascidians."
Chemical, Burlington-house, W., 8 p.m. 1. Mr. F. D. Brown, "Fractional Distillation" (Part II). 2. Mr. W. E. Adeney, "The Estimation of Hydric Peroxide by Means of Potassic Permanganate." 3. Mr. H. B. Dixon, "The Oxidation of Sulphurous Acid."
Royal Historical, 22, Albemarle-street, W., 8 p.m. 1. Mr. Frederick G. Fleay, "History of Theatres in London, from their first opening in 1576 to their closing in 1642." 2. Mr. J. Baker Green, "The Analogy between Jewish and Christian Baptism in the Apostolic Age."
Numismatic, 4, St. Martin's-place, W., 7 p.m.
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. J. H. Maughan, "Drainage of North Lincolnshire."

Friday, April 22nd...Mechanical Engineers, 25, Great George-street, S.W., 7½ p.m. Reading of papers and discussions continued.
Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. T. Charters White (President), "The Histology of the Gustatory Organs of the Rabbit's Tongue."
Folk-Lore, 22, Albemarle-street, W., 8 p.m. Mr. Hyde Clarke, "The Relation of English Folk-Lore to the English Language, and the Influence Reciprocally Exercised."
Clinical, 53, Berners-street, W., 8½ p.m.

Saturday, April 23rd...Antiquaries, Burlington-house, W., 2 p.m. Annual Meeting.
Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, APRIL 22, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

FOREIGN AND COLONIAL SECTION.

Tuesday, April 5, 1881; John Rae, M.D., F.R.S., in the chair.

The paper read was—

CANADA: THE OLD COLONY AND THE NEW DOMINION.

By E. Hepple Hall, F.S.S., &c.

I.—Historical.

Whatever estimate may be placed upon the claims of Canada as a field for British settlement, in comparison with those offered by other portions of the British Empire, there can be no question of the paramount interest which our Home Colony possesses from a historical point of view. Her place in history is indeed as unique as it is remarkable. No part of our world-wide colonial domain has passed through so many or such stormy stages of existence. Nowhere within the circuit of the Crown territory have peace and war, union and separation, loyalty and rebellion, followed each other in such quick succession. In none have the struggles between Church and State, between party and party, between Parliament and people, been more bitter, or the great political changes which they have contributed to hasten been more sudden or more sweeping. Nowhere have the patriotism of the subject, the supremacy of our arms, or the prestige of our flag been more severely tried, and nowhere have they been more nobly vindicated or more heroically sustained than in Canada. It will be my honour and privilege, in the paper which I have now to submit, to trace these varied stages in her history; to note her growth from the infant quasi-colony of a foreign power, to the proud position which she now occupies as an integral portion of this great empire; to portray, as well as the short time allowed me will permit, the more important political changes by which each succeeding stage has been marked, and to state, as far as practicable, the results which the present current of events is likely to bring about.

To begin at the beginning, there was little in the early existence of Canada to indicate the position which she has already acquired; still less was there to foreshadow the greatness to which she is surely yet destined to attain. The hardy and adventurous Norsemen, if they ever really sighted the Canadian shores, which is extremely doubtful, certainly never landed on them. The occupation at least, if not the discovery of the country, was reserved for later times, and for another race of people. The best authenticated discovery and earliest attested history we have of the country now called Canada are associated with the exploits of that brave band of Venetian navigators who shed such lustre on the closing annals of the fifteenth century. Our North American and South African colonies started in the race of empire—rather let us say took up their appointed places in the circling orbit of our civilisation—together.

While Diaz and Vasco de Gama were seeking a new route to India by way of the Cape of Good Hope, the Cabots, father and son, were tracking the stormy Atlantic, and hunting for a north-west passage, in hopes of ultimately reaching the same goal.

In the very same year (1497) in which the Portuguese navigator weathered the Cape of Storms, and sighted the low-lying coast of Natal, his Italian compeer, accompanied by his son Sebastian, leaving their adopted home, Bristol, in the little barque *Mathew*, which the English monarch had given him, caught the first faint glimpse of the iron-bound coast of Newfoundland. It was only a glimpse, a first sight, a *prima vista*, and so Cabot called it. Two years subsequently to Cabot's voyage, Gaspar de Cortereal, a Portuguese adventurer, hoping to accomplish what his predecessor and competitor had failed to find—a north-west passage to India—set sail from Lisbon, and with two ships reached the Labrador coast, which he named "Terra Verde." He entered the Gulf of St. Lawrence; but of further exploration by him we have no authentic trace.

Thus far discovery on the North American coast had resulted wholly from the desire to discover a north-west passage to India. Not only was the island which now bears the name Newfoundland an actual *terra nova*, but the Labrador coast, and Acadia to the south of it, were in the same category of newly discovered or found lands; and thus they stand roughly outlined on the maps of that period.

Period of Settlement.—The first voyage to North America with a view to settlement is that recorded by Mr. Beamish Murdoch, of Baron Lery et de St. Just, in 1518. Six years later, Francis I., of France, aspired to enter the lists with Spain and Portugal for the acquisition of territory and sovereignty in America. Under his direction, Giovanni Verrazano, a Florentine, was despatched (January 17th, 1524) in the ship *Dauphine*, with fifty men, and provisions for eight months. Little came of Verrazano's visit, save the glory of the occasion. Similarly barren of practical result seems to have been the visit of a "learned and wealthy English citizen of Bristol," Master Thomas Thorne by name, who, favoured with the patronage of King Henry VIII., fitted out two ships, and set sail in May, 1527. Entering the Straits of Belle Isle, and through them reaching the Cape Breton and Acadian shores, the ambition of Thorne and his companions, or more likely their provisions,

failed them, and they returned to Bristol in October of the same year.

Thus fitfully and feebly were the attempts to found settlements on the coast of North America carried on, until the close of the first quarter of the sixteenth century. England's flag of discovery had been thus far wholly in the hands of foreigners; and he would have been a bold man who would then have predicted that England would so soon become the first maritime nation in the world. A floating population, consisting of a few hundred hardy, but humble, Norman and Breton fishermen, roughly subsisting on their frail barques and brigs, anchored on the open Newfoundland banks for seven months in the year, scudding before a stiff nor'-wester, or sheltered between the headlands on some part of the Acadian coast, formed the only appearance of what could be called a settlement or colony. It is not until we come to the French exploration and occupation, that we reach what may fairly and distinctively be called the first period in the history of Canada. This period opened with the voyage and landing of Jaques Cartier, in 1534.

French Occupation.—During Cartier's first visit little was accomplished in the way of actual settlement. Capture and conquest, or conversion, not colonisation, have ever marked the policy of the French in the New World. Cartier seems to have contented himself with anchoring his little fleet off the ancient Stadacona, at the confluence of the St. Charles and St. Lawrence rivers, and of afterwards navigating the river as far as Hochelaga, where he made the acquaintance of the Huron-Iroquois tribe of Indians, and of their king or *Agouhanna.* Cartier's next visit was made in 1541, in company with Francis de la Roche, Sieur de Roberval, whom the French monarch had created Lieutenant-General and Viceroy of his newly-acquired possessions. This was intended as a colonising expedition, the first of any magnitude of which we have any record. But, like that undertaken by Baron Lery in 1518, and, indeed, like most French colonising schemes, it was a failure.

The first actual settlement by Europeans within the territory of the present Dominion of Canada was made in 1605, by De Monts, at Port Royal, now Annapolis, in the province of Nova Scotia. This followed immediately on the formation of the "Company of New France," under patent from Henry IV., for "inhabiting Acadia, Canada, and other places in New France." Events now followed more rapidly. On July 3, 1608, Samuel de Champlain reached the bold headland at the confluence of the St. Lawrence and the St. Charles rivers, the spot where his brave countryman, Cartier, had wintered three-quarters of a century before, and founded the City of Quebec, and where fifteen years later he built Fort St. Louis. From this time till 1629, French exploration and colonisation in Canada was carried on mainly, if not wholly, by the priests. Bands of missionaries penetrated the country in all directions, zealously endeavouring to convert the Indians to the Christian faith. From Quebec, as a starting point, the missionary lines of the "Society of Jesus" radiated in all directions through every inhabited region, from the Laurentian Valley to the Hudson's Bay territory, through the region of the great lakes, and down the valley of the Mississipi. Scantily equipped, with a breviary round the neck and a crucifix in hand, the fearless priest set forth, the pioneer of commerce, and the *avant-courier* of civilisation. Christianity and commerce went hand in hand through Canada in 1630—1670, just as they go in Central Africa to-day, the merchant by the side of the missionary. Conspicuous among them were M. Joliet and Pères Hennepin, Marquette, Allouez and Dablon. Lasalle, setting forth from Fort Frontenac, had pursued his way to the southern extremity of Lake Michigan, the site of Fort Dearborn and of Chicago in later days, which he reached October 18, 1678. Four years later, the same intrepid adventurer took possession of the Mississipi Valley in the name of the French King, and claimed it as part of New France.

In 1670, Charles II. granted to Prince Rupert and his company of adventurers, since known as the Hudson's Bay Company, rights and privileges, which have worked a mighty revolution in the future of the whole North-West.

Consolidation of British Power.—Although the actual and sovereign dominion of France in Canada ceased with the famous passage of arms on the heights of Abraham in 1759, followed by the defeat of Montcalm, and the capitulation of Montreal in 1760, French influence continued to be felt in various ways. After the capture of Quebec, the country was placed under military rule. The French Canadians were guaranteed the free exercise of their religion, and their clergy continued to enjoy their accustomed rights and privileges. "La Nation Canadienne," though dead politically, was yet socially and ecclesiastically as vigorous and active as ever. The definitive treaty between England, France, and Spain, though it left England constitutionally stronger, was really only a prelude to further disturbance. Territorially, all that was left of "La Nouvelle France," were the little rock-bound and fog-capped islands of St. Pierre and Miquelon—a somewhat insignificant outcome from so ambitious a design as the conquest, conversion, and colonisation of half a continent. In 1775, the Quebec Act was passed, and in the fatal concessions to the French Canadians contained in this Act is to be found the origin of that anti-British feeling which, engendered by the powers so conferred, has been perpetuated, in some degree, to this day. The French criminal law was, however, superseded by the English criminal law.

During the years 1784-85, the maritime provinces of Nova Scotia and New Brunswick were organised under special constitutional charters, the first Legislature of New Brunswick meeting at St. Ann's, now Fredericton, during the latter year. The year (1791) was marked by the passage of the Constitutional Act, under which representative government was secured to the people. The slow, but steady development of the principle of responsible government in Canada under Lords Sydenham, Metcalfe, Elgin, Monck, and Lisgar, and the unswerving devotedness of Lord Dufferin to these principles, serve to make this one of the most interesting epochs of Canadian history. But we must pass on yet more rapidly to the close of the historical portion of my paper.

We now come to the period of confederation. On October 10, 1864, the Government delegates met the delegates of Nova Scotia, New Brunswick,

and Prince Edward Island, at Quebec, to consider a general scheme of confederation. This was known as the "Quebec Scheme." It was the beginning of the end—the definitive first step to the British North America Act, the Act of Union, the final Act and law, under and by virtue of which the Dominion of Canada exists to-day. Confederation was the necessary outcome and result of the partial and unjust basis of representation which had so long existed in the country. Notwithstanding its intrinsic excellence, its advantages were not immediately recognised. One by one the links in the lengthening chain of federal union were welded together. First, Nova Scotia, then New Brunswick, and finally Prince Edward Island joined hands, These several events extended over a period of nearly three years more. It was not until July 1, 1867, that her Majesty's proclamation declaring the Dominion of Canada an accomplished constitutional fact was legally recognised. "Dominion Day" is now kept as a commemoration holiday throughout the country.

In 1870, the ægis of the Dominion Government was wisely extended over the vast extent of country situate between the western boundary of Ontario and the Rocky Mountains, then known as Rupert's Land, and since as Manitoba, the district of Keewatin and North-West Territories. In 1871, British Columbia joined the Confederation, and in 1873, Prince Edward Island was added to the list. Newfoundland, and its dependency, Labrador, of all the Imperial possessions on the vast North American Continent, now alone remains a Crown colony.

Since Confederation,—The British North America Act, as just stated, came into operation on July 1, 1867. From that date Canada entered upon the last and—viewed prospectively—most important era of its history.

Lord Monck in opening the first Dominion Parliament at Ottawa, November 8, of that year, gave utterance to the following memorable words:—"I congratulate you on the legislative sanction which has been given by the Imperial Parliament to the Act of Union, under the provisions of which we are now assembled, and which has laid the foundation of a new nationality that I trust and believe will, ere long, extend its bounds from the Atlantic to the Pacific Ocean." The Province of Manitoba was admitted into the Dominion May 12, 1870, and the Act creating the District of Keewatin came into force shortly after.

II.—Geographical.

The Dominion of Canada as now constituted—first by the Federal Union of 1840, then by the Confederation Act of 1867, and subsequently by its extension of 1870-71 and 1873—embraces seven principal territorial divisions or provinces, each having a Government and Parliament of its own. It also includes the North-West Territories, Keewatin District, and the islands of the Arctic Ocean and Hudson's Bay, which are politically, as well as geographically, annexed to them. It extends east and west, from the 51st to the 141st meridian, and occupies a superficial area equal to one-fifteenth of the land surface of the world, rather more than the United States, and rather less than the whole of Europe. In the order of population they rank as follows:—

Area and Population of the Dominion of Canada.

Province.	Square Miles.	Population in 1871.
Ontario	109,480	1,620,851
Quebec	193,355	1,191,516
New Brunswick	27,322	285,594
Nova Scotia	21,731	387,800
Prince Edward Island	2,133	94,021
Manitoba	120,000	12,228
British Columbia, including Vancouver and other Islands	390,344	10,583
North-West Territory	1,898,000	No returns. —
Keewatin District	309,077	—
Islands in the Arctic Ocean	311,700	—
Islands in Hudson's Bay	23,400	—
	3,406,542	3,602,596

The population, according to the Census returns (1881), already made, but not officially announced, is estimated at 4½ millions.

It is with the comparatively narrow strip of settled country bordering on the Atlantic coast, extending through the St. Lawrence and Saskatchewan valleys on and near the proposed route of the Canadian Pacific Railway to the Rocky Mountains and Pacific Ocean—the fertile or food-producing belt—that I propose to deal in this paper.

As illustrating the composite character of the Canadian people, the following table, showing the nationalities of the four old provinces, according to the census enumeration of 1871, is of interest:—

	Ontario.	Quebec.	New Brunswick.	Nova Scotia.
African	13,435	148	1,701	6,212
Dutch	19,992	798	6,004	2,868
English	439,429	69,822	83,598	113,520
French	75,383	929,817	44,907	32,833
German	158,608	7,963	4,478	31,942
Greek	7	7	1	24
Half-breed	2	—	—	—
Hindoo	8	—	—	3
Indian	12,978	6,988	1,403	1,666
Irish	559,442	123,478	100,643	62,851
Italian	304	539	40	152
Jewish	48	74	3	—
Russian, Polish	392	186	1	28
Scandinavian	686	454	200	283
Scotch	328,889	49,458	40,858	130,741
Spanish, Portuguese	213	142	223	251
Swiss	950	173	64	1,775
Welsh	5,282	283	1,096	1,112
Various other origins	295	32	1	13
Not given	4,508	1,154	373	1,526
Totals	1,620,851	1,191,516	285,594	387,800

The Indians belonging to 36 tribes, number a little over 100,000. They form the relict of the four once numerous and powerful families or races of—1. The Esquimaux or Muok; 2. The Dénè-Dindgè; 3. The Algonquin; 4. Huron-Iroquois. They are scattered all over the North-West Territories and British Columbia, and constitute a large proportion of what may be called the "landed gentry and freeholders of this vast and promising region."

In the composition of her exisiting population, Canada is then still peculiarly favoured. Commencing as a French colony, Quebec has over a million of the descendants of the foremost nation

of the Latin race—a people distinguished, like their ancestors, for industry and thrift, combined with a natural courtesy and *bonhommie* which endear them to all. If the French Canadian is not, perhaps, quite on a par with his Anglo-Saxon brother in enterprise, he is certainly more than his equal in those amenities which beautify life, and cast a charm over even the hardships of the backwoods; while in devotion to his country, and loyalty to the sovereign under whom his condition has risen from serfdom to freedom, none can excel him.

Population.—The population of Old Canada (Quebec and Ontario), exclusive of Indians, in 1774, was 166,256. In 1806, the population of British North America, which included Newfoundland, had only reached 476,000. Since that time, more particularly since confederation, the growth of population has been very rapid. During the latter period the figures show a relatively greater increase than do the United States. Thus:—

	Inhabitants.	Increase.
1806	476,000	—
1825	581,920	24,000 per annum.
1831	1,069,000	
1851	2,482,000	70,000 ,,
1861	3,090,561	70,000 ,,
1871	3,833,000	
1881	4,500,000	67,000 ,,

If the present rate of increase, which is shown to be equal to 1·25 per cent., or 12·5 per 1,000 during the last ten years, is maintained during the next two decades, and it is more likely to advance than otherwise, the population, at the close of the present century, will reach, in round numbers, ten millions. According to the census of 1871, more than four-fifths of the population are native-born.

This rapid growth in population is largely owing to the uninterrupted influx of British immigration. Between 1850 and 1878, a period of twenty-eight years, 684,542 strangers settled in Canada, an average of rather more than 25,000 per annum.

Year.	Settled in Canada.	Year.	Settled in Canada.
1851	25,515	1867	14,666
1852	20,943	1868	12,765
1853	32,295	1869	18,630
1854	38,800	1870	24,706
1855	23,000	1871	27,773
1856	24,816	1872	36,578
1857	33,663	1873	50,050
1858	12,340	1874	39,373
1859	6,300	1875	27,382
1860	7,827	1876	25,633
1861	12,486	1877	27,076
1862	28,798	1878	29,807
1863	26,118	1879	30,717
1864	21,738	1880	35,425
1865	19,413		
1866	10,081	Total..	750,864

The forthcoming census returns will furnish us with such vital statistics as will enable us to estimate the precise rate of natural increase in the population of Canada, and these I hope shortly to communicate for a future number of the Society's *Journal*. It is slightly lower than the English rate, and not more than half that of Australia and New Zealand. It will be found, on close investigation, to be not far from 1·10 per cent., or 12 per 1,000. The settlement of the back country, rapid as that has been, has not thus far kept pace with the flow of population to the cities and towns.

The following list embraces the chief cities, with their population:—

	1871	1881 (Estimated.)
Montreal	117,225	160,000
Quebec	59,699	75,000
Toronto	58,092	80,000
Halifax, Nova Scotia	29,582	—
St. John, New Brunswick	28,805	—
Hamilton	27,716	—
Ottawa (Capital)	21,545	—
London	15,826	—
Kingston	12,407	—
Winnipeg	3,000	12,000
Three Rivers	7,570	—
Charlotte Town, Prince Edward's Island	7,500	—
Fredericton	6,006	—
Victoria	4,540	—
St. Hyacinthe	3,746	—

It is shown by the Board of Trade returns that, since 1815, no less than 7,000,000 have emigrated from these shores, of whom only 2,550,000 have gone to the Colonies, while 4,400,000 have for ever abandoned their allegiance and become citizens of a foreign country. I think (with Sir Alexander Galt) that this is a most deplorable fact, and becomes the worse if we regard them in the light of helpers of their former fellow-subjects at home.

The chief factor in this continued exodus from our shores is to be found in the over-population of the United Kingdom, and in the absolute necessity of providing againt the evils—ever increasing, and daily becoming more threatening—which are traceable to this cause. Emigration, continuous, progressive, and systematic, is the only certain remedy, and forms, at the same time, the only boon Canada asks from the mother country.

We have, since 1815, a total removal of population from the British Islands to other countries of the enormous number of seven millions, distributed very nearly in the following manner:—

United States	4,400,000
British North America	1,350,000
Australia	1,000,000
Elsewhere	50,000
	7,000,000

The striking and significant fact unfolded by these figures is, that up to 1841, and, indeed, until 1848, the movement of British population to British North America was actually in excess of that to the United States. After 1841, two causes operated to turn the flow of emigration more largely to the United States; the first was the condition of Ireland up to and succeeding the famine, the other was the passage of the Homestead Law and the contemporaneous opening up of the vast prairie States of the Union, which began to attract general notice after 1840.

The latter causes were, I think, much the more important, and to them I believe the United States are indebted for the rapid strides they have made in population and wealth, and the great attraction they have offered to the emigrating classes, not only of the United Kingdom, but also of Germany and of Scandinavia.

Reproduction.—I have already stated the emigration to have reached seven millions, of which at least four millions have left the United Kingdom since 1852. It will probably interest you to know that, notwithstanding this immense overflow, the reproductive powers of our population have more than supplied the gap. In 1853, the population of Great Britain and Ireland was 27,542,588; in 1879, 34,156,113, showing an increase of 6,613,525.

Considering this enormous increase of the resident population, coincidently with an emigration of 4,000,000 since 1852, it will scarcely, I think, be disputed that no more important question can permanenly occupy attention here, than the best mode of systematising and directing the outflow of the people. Had these four millions remained at home, it is probable that the position of affairs here would have been much more critical, and might have been even seriously dangerous. As an illustration of this, I will refer to the state of Ireland, as connected with emigration.

From 1861 to 1870	it averaged	81,858	
1871 ,, 1875	,,	65,893	
1876 ,, 1879	,,	29,898	

It does not appear an unwarranted deduction to assume that the comparative cessation of emigration, noticeable during the four years 1876-79, has intensified the evils in that country, which evidence clearly shows, on the west coast at least, to be traceable to over-crowding. When we plainly see that congestion of population has followed upon a decline or partial stoppage of emigration, it appears to me that the simplest and most speedy cure will in many districts be found in the systematic encouragement of voluntary emigration. I use the term "voluntary" advisedly; it is the only principle upon which any Government could act. If experience in the treatment of this great subject has taught us anything, it has taught us that the courses of emigration cannot be regulated by political considerations; and that colonisation is, after all, not so much a matter of State policy and Imperial legislation as of natural law and rightful selection. Mr. Parnell proposes to make the occupants of the Irish soil its owners, and Mr. Bright proposes the purchase of a million acres of waste land in Ireland, its improvement and drainage, and the division of it amongst 40,000 families, on farms of twenty-five acres a piece, a work which he said would be cheap at £10,000,000. Our contention is that it would be very much cheaper and easier, and therefore wiser, to spend this money, if money is to be spent, in encouraging emigration to a land where ownership in the soil is easy and its returns sure. Partnership in emigration, which most fitly formed the subject of Mr. McCullagh Torrens's, M.P., recent address before the Royal Colonial Institute, in order to recommend itself to the intelligence and conscience of the nation, must work equally for the benefit of the United Kingdom, the Colonies, and the emigrant—a fact which has been too little borne in mind in recent discussions on the emigration question.

But there is still another light in which this engrossing and all important theme of migration must be viewed. It is that of trade relations between the mother country and the nearest of her colonies. It will be seen by the Board of Trade returns that, on an average of the last three years, notwithstanding the recovery of prosperity was more early, every person, and, therefore, every emigrant in the United States, has consumed only 8s. 4d. worth of British manufactures, while in Canada he has consumed 32s. worth; it is, therefore, in the interest of British labour at home, in the proportion of 32 to 8, that emigration should go to Canada rather than to the United States.

I will now, with the aid of the map, do my best to pourtray to you some idea of the magnitude and value of the trust that has been assumed by our trans-Atlantic fellow subjects in undertaking the colonisation and government of the northern half of the great North American continent. Here you have presented a domain nearly as large as all Europe, stretching from the Atlantic to the Pacific Ocean, its southern boundary resting in the latitude of the South of France, and its northern line is washed by the waters of the Arctic Ocean. Possessed of the finest forests in the world, most prolific and profitable fisheries, watered by the most extensive system of fresh-water lakes and rivers, enriched with well-nigh every known variety of mineral, including abundant supplies of coal and iron, and now proved beyond any question to contain the largest area of fertile prairie and bread-stuff producing soil in the world—destined, at no very distant day, to become the granary of Great Britain, and the happy home of millions of our countrymen and women.

The Dominion of Canada is naturally divided into three great divisions—the Atlantic, or Eastern; the Central, or Prairie; and the Pacific, or Western.

The Atlantic division is that which comprehends the older settled provinces of Nova Scotia, Prince Edward Island, New Brunswick, Quebec, and Ontario. It contains almost the entire present population of the Dominion—about four millions, and is the only part of the British possessions in North America to which emigration has been hitherto directed. It may be described as the woodland, or forest section of Canada, and stretches from the Atlantic to the head waters of the great River St. Lawrence, west of Lake Superior.

The Central, or prairie division, containing the new province of Manitoba, and the adjoining north-west territories, extends from the densely wooded Atlantic region to the Rocky Mountains. Commencing with the valley of the Red River, the prairie extends westward over a gently undulating country, clothed with the most luxuriant grasses and beautiful flora, for a distance of a thousand miles to the base of the Rocky Mountains, varying in width of from four hundred to six hundred miles. This magnificent district, watered and rendered accessible in its eastern section by the great Winnipeg and Manitoba lakes, is in its central and western portion traversed by the mighty River Saskatchewan, with fifteen hundred miles of steamboat navigation, and fertilised by many beautiful tributaries issuing from the recesses of the mountains. With some comparatively insignificant exceptions, the prairie division of the Dominion contains probably the largest continuous tract of country in the world adapted to the growth of wheat and other cereals, and peculiarly fitted also for cattle-raising, especially on the western plateau, where cool and

abundant water is combined with an exceptionally moderate climate. Settlement in this section is now exceedingly active, and likely to be continuous. During ten months of 1880 (January to October), the total immigration returns were 17,981.

The Pacific section, known as British Columbia, comprehends the volcanic region west of the Rocky Mountains to the Pacific Ocean, with the magnificent archipelago of islands of which Vancouver and Queen Charlotte's groups are the most conspicuous. Possessing a climate much more temperate than that of Canada proper, British Columbia has an immense extent of land fitted for agriculture, while the mountain ranges which traverse the country are replete with minerals of every variety, and are, it is thought by some, quite as rich as the similar districts of California and New Mexico. Gold to the value of eight millions sterling has already been extracted from the gravel-washing alone, without the introduction of machinery. Vancouver's Island has, so far as known, exclusive monopoly of the coal supply of the entire Pacific coast, from Behring's Straits to Cape Horn; her coal-fields are inexhaustible in extent, and excellent in quality, and, in the future, must make this island the emporium of the China and Indian trade, while its importance in connection with the naval supremacy of England in the Pacific Ocean can scarcely be exaggerated.

Physical Geography.—The coasts of the Dominion are everywhere extensively indented. The most remarkable of these indentations form the extensive inland seas known as Hudson's Bay, the Gulf of St. Lawrence, and the Gulf of Georgia. The Hudson's Bay, the Mediterranean Sea of Canada, merits a separate paper, and will, I trust, ere long, find a delineator worthy of its growing importance. It is thus described by Dr. Bell, who has spent five years in exploring its waters and shores:—

"Instead of being, as is usually supposed, a part of the Arctic regions, its nearest shore is more southerly than London, and its farthest still remains within the north temperate zone. On the north-east coast there is little snow in winter, and little rain in summer. The tributaries of the bay are the Nelson, which discharges the waters of Lake Winnipeg; the Winnipeg, about the size of the Ottawa; the Saskatchewan, 900 miles long, pouring in from the west; and the Red River, coming 500 miles from the south. All the central part of North America, from Labrador to the Rocky Mountains, drains into Hudson Bay. The largest tributary is the Nelson, about four times the size of the Ottawa, at the capital; then comes the Churchill, the Big River, and the Albany. On the west side of the bay, the southerly winds are the coldest that blow in the winter, and there is less snow and less intense cold in the vicinity of York Factory and Fort Churchill than in more southerly regions. During winter, the temperature improves as one goes from Minnesota northward through Manitoba, and down the valleys to Hudson Bay, and bathing is found agreeable in July, August, and September. On the southern and western shore, unlimited supplies of red and white pine, spruce, white birch, balsam, poplar, aspen, and tamarac are found."

Owing to her remarkable physical configuration and extensive watershed, Canada possesses the largest lake and river system in the world. The volume and surface area of her lakes and rivers are equally remarkable. The hydrographical basin of the St. Lawrence, with the great lakes Superior, Huron, Michigan, St. Clair, Erie, and Ontario, alone occupy 330,000 square miles. They form the largest and purest continuous system of fresh water in the world, and impart to the Dominion a perfectly unique hydrographical character.

The lake system of Ontario and the central or prairie region embraces, among many smaller bodies of water, Great Slave, Great Bear, and Athabasca Lakes, Winnipeg, Manitoba, Winnipegoosis, and Lake of the Woods, Simcoe, Nepigon, and Nipissing.

Next to the St. Lawrence, the most important rivers of the Dominion are the Saskatchewan, Mackenzie, Peace, Nelson, Athabasca, Assineboine, Albany, Churchill, and Winnipeg, all flowing in the vast North-West territory; the Columbia, Fraser, and Thompson in British Columbia; the Ottawa, which forms the boundary between Ontario and Quebec provinces, and its chief tributaries the Gatineau, Madawaska, Keepawa, and Matawan; the Saguenay, Richelieu, St. Maurice, and Chaudière, in Quebec; the St. John, Miramichi, Restigouche, and Petitcodiac, in New Brunswick; the Shubenacadie, St. Mary's, La Have, Avon, and Annapolis, in Nova Scotia; and the York and Hillsborough rivers in Prince Edward Island. Only the better knewn of these rivers have been navigated to any considerable extent with steam craft.

Thus Canada possesses a continuous waterway from the Atlantic to the head of Lake Superior, and thence, with a few unimportant portages, or "carrys," on to Vancouver's Island, a natural highway of trade and travel, unequalled for extent and grandeur in the world, and the best, because the cheapest and healthiest emigrant route across the American continent.

"Climate," says Professor Ansted, in his admirable compendium of "Physical Geography," "is a very complex matter, and one dependent on a great variety of conditions." These to some extent affect and depend on each other, but all may ultimately be traced to certain general causes connected with physical geography. The meteorological service of Canada forms a branch of the General Department of Marine and Fisheries, and is most admirably superintended. The Central Office and Magnetic Observatory are at Toronto, and thence daily weather warnings are sent to more than 600 places throughout the Dominion, so that all speculation on that delightfully exciting subject of ordinary English table-talk is spared the Canadians, and the time turned to more profitable account. It is a matter for regret that the British mind, though certainly less abused than formerly in regard to the climate of Canada, is still greatly and unjustly prejudiced in regard to it. It is among the very healthiest climates in the world, as is proved by the bills of mortality. It greatly influences the formation of the robust constitution, and sturdy determined character for which the Canadians are conspicuous. Climate, and the difficulties attendant on overcoming the forces of the wilderness, naturally impart great energy and courage to such a population, and bring about those wonderful results of successful progress which excite the envy and admiration of the world.

Resources and Products.—Agriculture forms the chief and abiding interest and industry of the

Dominion. That farming pays in Canada is sufficiently proved by the fact that more persons are engaged in it than in any other branch of industry. In fact, nearly one-half of the whole population, at the last census, were then engaged in agriculture; and this proportion has, I think, been fairly sustained during the past ten years. By way of illustrating the rapidly progressive character of the Canadian farming industry, it is sufficient to quote the yield and export of the staple crops at three periods during the past half century. In 1820, the average export of wheat did not exceed 1,000,000 bushels. In 1850, it had increased to 30,000,000, and, in 1880, the grain and green crops amounted to 125,000,000.

During the last 20 years the wheat production has been greatly stimulated, and Canada now produces 40,000,000 bushels, and a total of 170,000,000 bushels of all crops, or about $42\frac{7}{8}$ bushels per inhabitant. When the wheat fields of the new North-West are fairly under cultivation, say before the close of the present century, Canada will have a wheat surplus for export of 100,000,000 bushels—sufficient to supply the deficit in the present wheat consumption of the United Kingdom.

Pastoral farming, which includes stock-raising and dairy farming—next to agriculture—is the most important industry of Canada, both soil and climate being favourable for its prosecution. Grasses, it is well known, thrive best in the region of summer rains and moderate summer temperatures, *e.g.*, in the middle and higher parts of the temperate zone. The high quality of Canadian dairy produce is now everywhere acknowledged. Ontario and the eastern townships of Quebec offer, perhaps, the best openings for those wishing to engage in this branch of business. Manitoba and the North-West Territories will, however, offer increased advantages as soon as railway communication is established through them. The quality of the wool, mutton, and beef raised on the grasses of the North-West prairies is even finer than that produced in the eastern provinces and townships. Cheese and butter, to the value of 8,500,000 dollars, are annually exported. The production of the former article advanced from 20,000,000 lbs. in 1874, to 40,000,000 in 1878. Beetroot is now produced in Ontario, and a company has just been formed for its further growth and manufacture into sugar. By recent Act of the Dominion Parliament this branch of industry is exempt from tax for eight years. The foot-and-mouth disease, and cattle epidemics generally, are unknown throughout the Dominion.

Canada, having an extremely diversified geological formation, is rich in minerals. In the Laurentian (or St. Lawrence) region, the mineral deposits are especially extensive.

Though every way subordinate to her fertile fields, her grand forests, and prolific fisheries, as a source of wealth, her mineral deposits must, as capital and labour make their influence felt in the country, attract increased attention and development.

No single province except, perhaps, Prince Edward Island, is without mineral deposits. Nova Scotia and British Columbia are rich in coal and gold,the total yield of coal in these provinces for 1880 being upwards of 900,000 tons. The following ores have been worked:—Gold, silver, copper, lead (galena), iron (magnetic), hematite (chromic and titanic), coal (lignite and albertite), apatite (phosphate of lime), graphite, mica, barytes, asbestos, slate, gypsum, petroleum, rock salt, antimony, iron pyrites, and manganese. The total exports for 1879 amounted to 4,000,000 dollars, or to rather more than three-fourths of a million sterling.

These minerals are not confined to any one province, but are found deposited in one form or another, and in greater of lesser quantities, in every part of the country, from the Atlantic to the Pacific. We can only mention a few of the more valuable mining districts and their chief productions.

Gold has been found and successfully worked, though in a small way, in British Columbia, Nova Scotia, Quebec, and in the Marmora and Medoc districts of Ontario. The method thus far pursued has been that known as "quartz" mining. The average earnings of miners at the present time is estimated at 700 dols. a year.

Silver is known to exist in several sections of the Dominion. By far the richest deposits thus far found have been on the north shores of Lake Superior, south of the Thunder Bay section of the proposed Canadian Pacific railway. Silver Islet has been pronounced one of the most extensive and valuable silver mining properties on the Continent. Thus far silver mining has been the merest surface scratching.

Veins of argentiferous *galena* are found in almost every section of Quebec south of the St. Lawrence.

Iron and Coal.—Iron exists everywhere throughout the Laurentian ranges. Nova Scotia takes precedence of all the other provinces in the extent and value of her coal and iron mines. There are some twenty mines in operation on the mainland and the island of Cape Breton, and they yield, on an average, one million tons annually. New Brunswick ranks next. Ontario, Madoc, and Quebec exhibit an annually increasing out-put of iron, but the difficulty of obtaining coal for smelting purposes, and the substitution, as far as practicable, of charcoal, is found to operate unfavourably to its extension in that direction. The coal mines of Vancouver (British Columbia), give employment to a large amount of capital and labour. Anthracite coal of fair quality is found on Queen Charlotte's Island. The "lignite" formations at "Roche Percé," in the Souris River Valley, in the vicinity of the 49th parallel, are now under survey by Professor Selwyn, whose report may shortly be expected.

Oil.—Petroleum, or coal oil, abounds in South-West Ontario, being largely distributed over the western peninsula.

Copper.—Canadian copper is noted for its purity. Mines have been opened along the shores of Lakes Huron and Superior. The "Bruce" mines of Lake Huron are said to yield copper ore to the value of £50,000 annually.

Salt wells and springs are abundant in New Brunswick.

Peat abounds in Quebec, in the island of Anticosti, and in come parts of Ontario.

British North America contains the most extensive and most valuable forests of timber in the known world. Fully one-half its entire surface is still covered with timber. The value of the timber

annually shipped may be roundly stated at 20,000,000 dols. Only the square timber is exported; the logs are manufactured into lumber at home. Forest conservancy and tree culture are, I am glad to be able to report, at last receiving deserved attention. The average Canadian farmer, like his compeer of the Republic, has hitherto displayed little taste in the management of his farm. He was wont to regard every tree as his enemy, and to ruthlessly hew and hack down every shrub and tree within reach of his stalwart arm. If he settled in the bush, the first thing he did was to clear a space round his house, and then he and his grandchildren went on clearing and clearing, until at last his home stood alone. In certain parts of the United States the law wisely offers a premium for trees grown, and the result is that barren wastes have become living forests, and ghastly homesteads have been surrounded by stately evergreens. Canadians must do the same, if they would maintain the hold which they have so long enjoyed in the lumber markets and ship-building yards of the world.

Fisheries rank third in importance among the sources of natural productions in Canada. "From Lake Ontario down to the straits of Belle Isle, a distance of nearly 2,000 miles, there is hardly a mile of coast line," says Rowan, in his charming book, "The Sportsman in Canada," "without a river or stream which affords fair angling." The sea-coast fisheries of Nova Scotia, New Brunswick, and British Columbia produce a handsome revenue to the country, and are capable of almost limitless extension. Compared with last year their produce is valued at about half a million more. The following tables, extending over a series of years, establish the fact that this improvement is not casual or spasmodic, but gradual and permanent. The value of the fish product for 1879 was 13,529,255 dollars, of which one-half was exported. This was an increase of 313,576 dollars over the yield of 1878; for 1877 it was 12,029,957 dollars; for 1876, 11,147,590 dollars. The production in each province of the Dominion was as follows:—

	1876.	1877.	1878.	1879.
	Dols.	Dols.	Dols.	Dols.
Novia Scotia	6,029,050	5,527,858	6,131,600	5,752,936
New Brunswick	1,953,388	2,133,237	2,305,791	2,554,722
Quebec	2,097,667	2,560,147	2,664,055	2,820,396
P. E. Island (840,344)	494,967	763,036	348,122	1,402,301
Ontario	437,229	438,223	—	367,133
Manitoba	30,590	24,023	—	—
British Columbia	104,697	583,432	—	—

The values of the different principal fisheries or products for 1877, were:—

	Dols.
Codfish	3,561,199
Herrings	1,522,091
Mackerel	1,667,815
Haddock	475,723
Salmon	855,687
Lobsters	1,213,085
Fish oils: cod, seal, whale, porpoise, dogfish, &c.	524,627

The number of fishery licenses issued in 1880 was 4,334, and it is estimated that fully 250,000 people, or one-sixteenth of the entire population, support themselves on this industry.

III.—Public Works.

The public works of Canada are on a scale commensurate with her own grand proportions. It may in truth be said that they compare favourably with those of any other country in the world. Their valuation, at the close of 1880, was 420,000,000 dols., equivalent roundly to £80,000,000, a sum more than twice greater than the Dominion debt. Of these works we can only now refer to the railways and canals, believing them to be the most important. The former, which already number forty-six main, or trunk, and branch lines, are rapidly increasing, both in number and value. Among the best known are the Grand Trunk, Great Western, Inter-Colonial, Canada Southern, Prince Edward Island, Northern and Canada Central roads. The last-named railway, in conjunction with the extension of the present Ontario railway system northward, from Gravenhurst to Calender station, will form a most important link in the through line, which will ultimately extend from Halifax and Quebec to Vancouver Island. Trains are now running westward of Deux Rivieres, and it is announced that the entire line to South-East Bay (Lake Nipissing) will be completed by December next. The mileage of the entire railway system in operation and under construction at the close of 1880 was 7,906, a very satisfactory exhibit for a population of less than four and a-half millions. Of the character of many of these lines it is needless here to speak, except to say that as regards both construction and equipment they compare most favourably with the best and most popular of the United States roads.

The Canadian Pacific Railway—the Bill incorporating, which has just passed the Dominion Parliament—is now in the hands of a strong syndicate of English and Canadian capitalists, and it is confidently believed that this great undertaking—the most extensive, and judged by possible results, the most important public work yet undertaken on colonial soil—will be pushed with the enterprise and vigour so characteristic of our Transantlantic brethren. Its length, when completed, will be 2,600 miles. Of this, as most of you are aware, 264 miles, or 10 per cent., are now under traffic, 600 more, on the Superior and central sections, are promised before December next, and we have the assurance of those who have the best right to an expression of opinion on the subject, that before the close of 1885, communication by water and rail between this dear mother-land of ours and the remotest verge of the "Big Farm," which future generations of her sons and daughters are to people and make productive, will be complete and in working order. The track on certain sections of the line in the prairie country, has been laid at the low figure of 13,500 dollars, or less than £3,000 per mile. To practical engineers among us this fact will serve to illustrate the favourable conditions under which the whole line between Lake Superior and the Rocky Mountains will be constructed. The precise terms of the agreement between the Dominion Government and the Canadian Pacific Railway Company have not yet been officially announced, nor would this be the place to discuss them if they were. Enough, however, is known to satisfy even the least hopeful among us that this magnificent enterprise will, ere long, be among the accomplished

facts of this marvellous nineteenth century, and that both Government and company are to be congratulated on the bargain they have each, by favouring circumstances, been able to make. What is so unmistakably for the general good of the whole nation cannot, in the long run, result in pecuniary loss to anybody. Nor need the absurd fears which have begun to be felt in home quarters in regard to the creation of a gigantic railway and land monopoly be longer entertained. The Dominion Government, it should be borne in mind, possess an interest in the lands of the North-West, far exceeding that granted to the railway company created by them. They have between 100 and 150 millions of acres to dispose of over and above the grant of 25 millions for the construction of the railway. This valuable measure will tend to check any usurpation of power or improper discrimination of privilege at the hands of railway companies or land speculators. Moreover, the company is bound by the toll clause of the Railway Clauses Consolidation Act, cl. 9, sec. 17, which enacts that "No tolls shall be levied or taken until approved of by the Governor in Council, nor until after two weekly publications in the Canada *Gazette* of the bye-law establishing such tolls, and of the Order in Council approving thereof." It may be remarked in this connection, on the authority of the Dominion Finance Minister's last report, that the railway system of the country was never before in so prosperous a condition.

Canals. — The canals of the Dominion cost £7,500,000, or about one-tenth the amount invested in railways. They need not be more particularly described in this paper. They form the links, so to speak, in the ever-lengthening chain of trans-Continental commerce, and those wishing to know more about them will find the whole subject exhaustively treated in the comprehensive "Handbook of Canada," just announced for publication by Messrs. Silver and Co., of Cornhill, the proof-sheets of which have been courteously furnished me, and largely availed of in the preparation of this paper.

A uniform enlargement of the whole canal system is now in progress, which will enable vessels of 1,500 tons to pass from Lakes Superior, Michigan, and Huron, through Lake Erie to Montreal and the open sea. When completed, the canals of Canada will practically extend ocean navigation to the head of Lake Superior, and thus put our kinsmen and neighbours in a position to compete successfully with the Americans in the vast and all but limitless trade of the west and north west. As is pretty well known among freighters, shippers, and business men generally, the real competition between rail and water lines, *e.g.*, between the American and Canadian systems, commences at the lower end of Lake Erie.

The telegraph and lighthouse systems of the Dominion fitly supplement the other branches of the Public Works Department first referred to. A year or two ago the Canadian Government became alive to the great importance of a telegraphic system connecting the islands, lighthouses, and ports of the Gulf of the St. Lawrence together, for the better protection of the fisheries, and the salvage of shipwrecked vessels. Not only has this most humane and prudent scheme been carried out, but a telegraph line from Red River across the "Fertile Belt" to the Rocky Mountains, and thence to Vancouver, has been completed, while a Bill has been granted for its extension thence by submarine cable to Japan, China, and our Indian possessions.

All the most important colonies and dependencies of Great Britain will, by means of this line, be placed in direct and continuous communication with the parent Government, without passing through any foreign hands whatever. The total cost of the cable is estimated at four millions of dollars, or about £800,000, which sum includes the completion of the Dominion land lines.

Defence.—The defence of Canada is, since confederation, wholly in the hands of her own sons. The law requires that every able-bodied man may be enrolled in her defence. The active militia force numbers 40,000, and the reserve force 600,000 men. Reporting upon Canada's system and means of defence, Lieut.-Col. Strange, commanding Quebec citadel, says:—"Owing to the peculiar configuration of the southern boundary—on which side alone it is open to attack—few vulnerable points exist. The Intercolonial and Grand Trunk systems, supplemented by the Dominion Railroad system, generally enable the troops and militia to act upon what are practically interior lines."

The trade of the Dominion has made itself felt only within the last fifty years. The first steamer navigated the St. Lawrence waters as early as 1809, but commerce advanced with slow and measured step for more than twenty years after that date. Since 1829 trade has multiplied fifteen-fold, a rate of increase fourfold greater than that of its population.

For the first time in the history of the Dominion, says a recent writer, we find an excess of exports over imports to the amount of nearly a million and a half dollars. Our trade with Great Britain, in 1880, was about £16,000,000 sterling, an increase of more than two millions and a half sterling over 1879. Our trade with the States decreased by over a million and a half sterling. Our trade with the West Indies and South America amounted to about £1,500,000, an increase over 1879 of £400,000 sterling. Trade with China and Japan shows an increase of £405,000. The export of manufactures. increased by nearly £1,000,000 sterling. In 1879-80 the inward and outward tonnage amounted to 6,786,000 tons against 6,088,558 tons the previous year, an increase of 700,000 tons. Upwards of 113,000 of her hardy sons sail the broad ocean in ships, pulled, masted, and sparred from timber grown in her own grand forests. To sum up this branch of our subject it may be remarked that Canada, with a population of four and a half millions carries on a trade equal in value to that of Great Britain at the beginning of the century, with a population of nearly sixteen millions.

Canada is to-day the fourth maritime power in the world. Her sails are unfurled in every sea, and her hulls are found in every port. At the close of 1880, the register of her shipping included 7,377 vessels, with 1,311,218 tons. Of these, 797 are steam craft, having a capacity of 158,862 tons. The total net value of her shipping is nearly eight millions sterling. Perhaps no readier or safer indication of the growth of Canadian trade can be adduced, than that furnished by the

experience of our common carriers, the great ocean steamship lines. Sixty years ago, the Messrs. Allan commenced sailing ships from Glasgow to Canada, and 28 years ago they built their first steamship, a vessel of 1,500 tons, for the mail service between Liverpool and Canada. Now this has expanded to a fleet of 24 ocean steamships, amounting to over 70,000 tons, while the total tonnage owned by them amounts to very close on 100,000 tons. There are also three other regular steam lines, the "Dominion," "Temperley," and "Beaver," besides occasional cargo steamers which ply between British and Canadian ports. Within the present year, a new steam line, under a Government subsidy, by Canada and Brazil, will open the markets of that vast empire to the varied produce of the Dominion, and it is every way probable that similar relations will shortly be established with France and the Spanish West Indies. Increased steam service is also asked between the maritime provinces and England, for shipment of cattle, &c. Now, a word or two only on a subject of great interest—I may say of principal and interest—the debt of Canada.

Finance, Debt, &c.—The entire debt of Canada on 30th June, 1880, was 199,125,323 dols., equal to £40,000,000, reduced by sinking funds and other assets to 156,942,471 dols., or about £32,000,000, equal to £9 9s. 4d. per head, against £46 per head in New Zealand, and nearly £21 in Victoria. The taxation for the present year, Sir Leonard Tilley assures us, will not exceed 22s. 6d. per head, or less than half the average taxation of the Australian Colonies.

The guarantees by the Imperial Government on Canadian account are thus stated in the Finance Account for 1879-80, March 31:—

For construction of railway from Revire du Loup Q. P to Truro, Nova Scotia	£3,000,000
Purchase of Rupert's Land	300,000
Canadian Pacific Railway and Improvement of Canals	3,000,000
By way of security for these guarantees, amounting to six millions three hundred thousand pounds sterling, there is a sinking fund against the first guarantee of ..	358,600
Against the second	39,800
Against the third........................	86,400
	484,800
	6,300,000
	£5,815,200

There would, therefore, appear to be a balance of rather more than five and three-quarter millions sterling, the payment of which, by Canada, has been guaranteed by the Imperial Exchequer. The interest on this sum is promptly paid by the Dominion, and Mr. Gladstone has, himself, publicly stated in the House of Commons, that not only has the pledge of the Dominion Government never been violated, but that her credit is to-day stronger than ever.

The national policy, according to Sir Leonard Tilley's last budget report, is, on the whole, worthy of the confidence of its founders. He at least entertains no doubt as to the revenue creating power of the present tariff, or of its ability to meet all the requirements of the country.

The deposits in the Dominion Post-offices and Savings'-banks afford a sufficiently good test of the general prosperity of the people. They amounted in 1878 to nearly nine millions of dollars; in 1879 to nearly ten millions, and in 1880 to 11,688,356 dollars. On the 31st of January of the present year they were 14,730,594 dollars, showing an increase of 5,732,481 dollars—more than a million sterling—in the peoples' savings. This added to bank deposits of twelve millions, makes a total of 18½ millions of increased deposits during the past year.

With these brief and somewhat hurriedly delivered facts and figures respecting Canada, my paper must close. The Home Colony is before you in such colours as a careful study of her resources and needs enable me to present. Her past is full of interest. Her future is full of promise. There is no need to exaggerate her advantages or unduly enforce her claims upon the attention of a loyal and home-loving people. The silken tie of sympathy which, for more than one hundred years, has bound the mother country to her oldest and nearest, and—may I not add—dearest colony, will shortly be strengthened by the iron bars of a common material interest, thus linking this Britain of ours with the dominion in stronger political, social and commercial union, for purposes of mutual support and defence. Though we may not say with the poet what our American cousins are never weary of repeating—

> "No pent up Utica contracts our powers,
> The whole, the boundless continent is ours"—

Though we may not, I repeat, say this, let us hope and trust that the day is far distant, may, indeed, never dawn, when our flag shall cease to float over any portion of our present North American domain. Never may we cease to feel the emotions of patriotism and pride which instinctively rise in our heart as we recite the words of our own glorious sailor bard:—

> "O'er the glad waters of the dark blue sea,
> Our thoughts as boundless and our souls as free:
> Far as the breeze can bear, the billows foam,
> Survey our empire and behold our home."

DISCUSSION.

Mr. Lionel Boyle intended to limit his remarks to one portion of the immense Dominion of Canada, Manitoba, described in the poetical language of Lord Dufferin as "the keystone of the mighty arch of provinces stretching across the entire continent from the Atlantic to the Pacific Ocean." It was strange that the capabilities of so fertile a country should have remained so little known in England, but it had been much separated from the rest of the world by want of railways, and, to some extent, also by the reluctance of the Hudson's Bay Company to encourage general emigration to one of the best countries for breeding furred animals. Every practical man who had visited it, including Lord Dufferin, had admitted that there was no finer or more fertile country in the world. People said of it that the winters were too long and too severe, but they were not so long or so severe as those of Russia, at all events, in the latitude of St. Petersburgh, and the severity of her winters had not prevented Russia from becoming a great nation. Very strange it was that of the 7,000,000 emigrants from this country who had been referred to, so large a proportion should have gone to the United States, from an idea that the States offered greater advantages to settlers than our own colony, for that idea was erroneous. There should be some systematic means devised of inducing people to

emigrate to that grand country, whether by Government aid or private enterprise. The relationship of England to her colonies should be that of a mother to her children; but, while she had had every opportunity of developing herself at their expense, she had not yet tried her hand at helping them. The total emigration from this country during the last 49 years had been 7,782,209, of which two-thirds, or 5,226,000, had gone to the United States, while British America and Australia had only received a little over 1,000,000 each. Surely it was time that was changed. A time might arrive when it would be desirable that the wheat we required should come from our own colony, instead of from the United States, though war with the latter was not probable at present, and that wheat supply could be furnished by Manitoba. Much might be done to promote emigration to our own colony, instead of to the United States, by the reading and publication of such papers as they had just heard.

General Lowry, C.B., agreed with the reader of the paper upon the urgent necessity of information being more widely diffused amongst all ranks of people at home, with regard to the value and importance, as emigrating fields, of our own vast and fertile territories abroad. Instead, however, of recuperating and recruiting ourselves by transplanting our people to our own colonies, we were absolutely exhausting ourselves, by letting them, from lack of proper information and arrangements, and it might be, in certain cases, of some measure of help from Government, drift away to another, though kindred, nation. While it would be not less unwise than unfair to attempt to coerce emigration in any way, or to narrow it into any one channel, he considered our policy so far had been fatally neglectful of our true interests as a nation, and by no means as beneficial to those who left us as it might have been. Such a paper as they had heard should be the means of calling greater attention from the public and from the Legislature to the vast and pressing importance of the colonies. They were, he believed, God's best gift to us as a nation, and needed a large, a wise, and more generous treatment. He could not but feel that, to a great extent, on our use of them now, in the crisis of their young manhood, would depend the continuity of their love of the old home and flag, and our own true greatness as a nation. Mr. Hall had touched briefly, but well, on another most pressing and important subject—that of colonial defence, of strengthening all essential parts for the safety of the whole expanse of British North America, and might he not add of the empire of the Crown of England throughout all her dominions. He very rightly, and specially called attention to Vancouver's Island, and the Pacific Coast. That island was indeed most valuable, not only from its coal deposits, and their feeding powers for the naval and mercantile marine, but from its position on the highway to Japan, China, and India. Mr. Hall had done well to touch upon Imperial defence. It was to be hoped that the Royal Commission now engaged on this point would meet it in its entirety, and that fuller scope would be given them to do so. Having commanded a regiment for many years in and throughout almost all parts of British North America, he could fully verify all the reader of the paper had said as to the material composing the defensive force of that country, for no finer men, or hearts more loyal to the Crown of England than in the soldiery of Canada could be found anywhere.

Mr. James Edgcome pointed out that there seemed to be a general agreement among those present as to the desirability of the confederation of the mother country with our colonies, but some practical means of initiating and carrying out this policy had not been alluded to in the preceding remarks. That policy could only be carried out on the basis of mutual interest between the home country and our Colonial Empire. It was absolutely impossible, in the present comditions of trade with America, and the physical disabilities under which the Dominion still labours, for us to expect to receive the whole of our American food supply at all seasons, or even, perhaps, at any season of the year, from Canada in preference to the United States. Canada should be treated by us as a part of our own country. The British farmer might be brought some day to regard migration from the mother country to a colony in the same light as he would regard migration from Cornwall to Northumberland, and when once that idea was accepted, emigrants would not be so easily tempted to foreign lands. One danger before us was, that the more valuable Canada becomes (and she was becoming more valuable every decade) the more likely were we to lose her. There was a strong feeling now existing in the United States in favour of the fiscal absorption of Canada. This was well illustrated by a recent article in the *Chicago Tribune*, referring to the policy of Mr. Blaine, and advocating the present time as a good opportunity for "including the whole continent north of Mexico under one system of commercial regulation, whereby one and the same tariff law, the same scale of duties and imports, the same Custom-house rules shall prevail everywhere, alike in the United States and in the Dominion provinces." That was a material danger ahead, involving the probability of a wall of hostile tariffs against us right along the North American seaboard. The panacea for this danger, in his view, was to aim at a Customs union between every portion of the British Empire, as against those parts of the world that would not join us in full and fair commerce.

Mr. Pfoundes said the valuable paper read that evening would, through the medium of the columns of the Society's *Journal*, extend far beyond those who had had the pleasure of hearing it read, and it was to be regretted that lectures, conveying similar information, were not delivered throughout the provinces and in Ireland for the benefit of intending emigrants. With regard to the history of those earlier explorers of North America, the Cabots, he would point out that there existed quite a literature concerning them, which was not open to the ordinary reader. It was erroneously supposed that they were Italians, but, in fact, they had been traders of Bristol for a generation or two. Cabot's maps, charts, and papers were entrusted to a person who had apparently betrayed his trust, for on the death of the great navigator, it was found they had disappeared. Remembering the rivalry that existed between the Spaniards and Portuguese at that period, it might easily be imagined how those documents came to be suppressed by people whose interest it was to do away with them. From searches in the libraries, however, he had satisfied himself that, however scanty the information on the subject might be, some was to be obtained. Having lived for a long period, as boy and man, in the colonies, he had taken interest in many emigration schemes brought forward for the mutual benefit of the colonies, and of emigrants especially from Ireland. But the right sort of emigrants would never be obtained by Imperial schemes. Without venturing into the forbidden region of politics, as a member of the Colonial Institute, he could say that their motto was "a united empire." If that motto were not acted upon, we should lose the colonies, though not from a want of loyalty in the colonists themselves. He had been one of the midshipmen appointed to the first Victorian war vessel, the steam-sloop *Victoria*, and therefore knew something about colonial loyalty. If the Imperial Government could in any way devote public money to assist emigration, it should be done in a way that would not injure the self-respect of the people, but leave to themselves the choice where they would go. Each colony had at present its own emigration agent in England, trying to get as many passengers and much money as possible; and what was wanted was a national emigration agency, where

people of all classes could go and get unbiassed, unprejudiced information, where each particular case would be taken into consideration as to ability, trade, or physical strength, and each person advised to go to the place most suitable for him.

Dr. Mann, having alluded to the practical character of the paper, drew attention to the circumstance that the Canadians appeared to be so generally able to occupy themselves in agriculture, a fact of great importance in considering the character of the colony. Then the aboriginal population was 100,000, instead of 700,000, as in such small territories as the Transvaal, or 360,000, as in Natal. That was an important fact for persons seeking to live by agricultural labour. If once a good system of starting emigrants in their new sphere of life could be organised, there would be no difficulty in filling our colonies with a large and prosperous population. The difficulties of colonisation were enormously increased, by having to deal with native populations ready to work for next to nothing. As the facts stood, in Canada there was a large territory of as yet uncultivated land, and no competition with cheap native labour.

The Chairman, in reference to competition with aboriginal labour, said that at any rate the Esquimaux would never be in the way, and even if they should, a more easily civilised people did not exist. He had had experience of them, and had found they were honest, and could be trusted to respect the rights of property, and to do no harm to anybody. It was a fact that their women were more clever than the men, and were always applied to by travellers for information. Their superior intelligence was no doubt attributable to the fact that, unlike other savage races, the Esquimaux did not make their women mere beasts of burden, but left them simply to the performance of their household duties. The nearest Esquimaux were, however, located in a portion of the territory which would not be settled for many years to come. With regard to another branch of the aboriginal population, the Indians of the Saskatchewan territory, to whom lands had been granted by the Canadian Government, were already beginning to cultivate the crops, and to breed cattle. The probable eventual separation of the colonies from the mother country had been alluded to in the discussion, and no doubt the separation would take place when the colonies found it convenient, but we should endeavour to part friends with them, and not try to coerce them, as we unhappily once tried to coerce the United States. They would then remain our friends, and send to us for what they want in preference to other countries. As to the suggested absorption of Canada into the United States, probably the Canadians were no more admirers than himself of the change of Government there every four years, with all its attendant political and financial disadvantages. The country had proved to be capable of raising a very hardy and powerful people. Several generations ago, a colony of Highlanders had gone out to a place called Glengarry, and their descendants had become still larger, more vigorous, and more powerful men, perfectly impervious to the cold, and he might say more Scotch than ever in their enthusiastic maintenance of the national customs. Personally, speaking of climate, he had been more tried here in London during the last ten days by the weather than he had ever been on an Arctic station in British North America. To fairly healthy people, the cold of Canada was stimulating. Physically, the conditions of the country varied, but, in the great fertile belt, the yield of crops was double that in the Western States of America, for whereas in that part of Canada the usual crop per acre was thirty bushels, an average crop in Minnesota, Illinois, and other Western States, gave only fifteen bushels to the acre. In Lower Canada, the French settlers had kept together in families on the same bits of land, which, though ample for one or two, would not suffice for half-a-dozen, and, consequently, a large part of Lower Canada had suffered from over-stocking. The Saskatchewan Valley presented simply a succession of luxuriant grass and pasture lands. Another point to be noticed was the large ship-building trade of Canada. Some iron vessels were constructed there, and all their own wooden ships were built in the Canadas, Nova Scotia, or New Brunswick. It could not be disputed that the military force there was as fine a body of men as existed in the world, accustomed to do everything for themselves, and they were all naturally good shots, their hunting habits having taught them to judge distances. In conclusion, he proposed a hearty vote of thanks to the lecturer.

Mr. Hall, in reply, said that the subject of emigration formed the gist of his paper, and he had only put Canada specially forward as the wealthiest in resources of our colonies. Upon the subject of the defence of Canada, he was glad they had had the advantage of hearing General Lowry, an old and tried officer of the Canadian forces. Had Captain Colomb been able to be present, he would, no doubt, have given them the benefit of his knowledge on the subject.

General Lowry explained that he had left that gentleman on a bed of sickness, and that he extremely regretted his inability to attend.

Mr. Hall, in continuation, acknowledged the cogency of Mr. Edgcome's remarks on the colonisation question, and on the possibility of a separation between the colony and the mother country. Both sides of the great international boundary in North America were peopled by Englishmen, and, therefore, something like unanimity of feeling, if not of political sentiment, might be looked for among them. No doubt, a kind of Zollverein, or general customs, had been attempted in the trade interest, but that in no way showed antagonism or a desire on the part of the United States to absorb Canada. It was, in fact, much more likely, as had been incidentally observed, that Canada would absorb the United States. A very friendly competition had sprung up between the two countries since the abrogation of the Reciprocity Treaty, and a large party in the United States, notably in Massachusetts, had advocated its resumption, but the Canadians, he thought, were not ripe for that yet. They were satisfied with their present national policy, and would probably remain so for many years to come. He had heard something in Montreal about annexation two years ago, but the desire for it did not exist among any very great portion of the Canadian people, an overwhelming majority of whom were not only intensely loyal to the British Crown and flag, but immeasurably opposed to anything like annexation by the United States. As to the nationality of the Cabots, he was aware they were not resident Italians; and he was indebted to Mr. Pfoundes for his offer of further information on the subject. They had certainly always had the credit of being among the discoverers of this wonderful country, especially in the neighbourhood of he Nova Scotia coast. On the subject of emigration schemes for the colonies, Mr. McCullagh Torrens had lately expressed himself in favour of a joint Commission, and in that way probably the interests both of the mother country and the colonies who were to take our surplus population would be best consulted. A joint Commission, to take into consideration the whole subject of colonial emigration, was what was wanted in place of the present system of emigration agents, each advocating his own particular colony. Having specially watched the course of emigration during the last 30 years, he was afraid that in too many instances we had sent out round posts to fill square holes, and a proper scheme of emigration was urgently needed. As Dr. Mann had said, it was a great advantage to colonists in Canada that the aboriginal population, with their cheap labour, numbered but 100,000 to 4,500,000 British and

Europeans. They were, however, of some use in that respect, and it was very creditable to the Indian Bureau of the Ottowa Government that they had been able to make such good use of the aboriginal inhabitants. Another extensive survey of the Hudson's Bay coast was being now made, and it would shortly be known whether the navigation of those waters for five months' in the year was really practicable. The necessities of commerce were so great that the importance of raising bread-stuffs and conveying them directly through Hudson's Straits to the British markets, in English bottoms, without transshipment, could not be over-estimated. In conclusion, he thanked the meeting for their courtesy and attention.

The Chairman, pointed out that it was only now that Canada had, by the opening up of Hudson's Bay, made available a vast tract of prairie land which could compare with that of the United States, and as her climate was preferable to that of the States, it might now be seen which of the two countries would attract the most emigrants from Europe.

The meeting then adjourned.

MISCELLANEOUS.

ART NEEDLEWORK.

English ladies were once so famous for their proficency in art needlework, that a particular kind of work was named *opus anglicanum*, and the productions of their needles were eagerly sought for abroad. In course of time they lost their position of pre-eminence, until, in the eighteenth century, the *Spectator* censured the young women for neglecting an employment eagerly followed by their mothers, and in the nineteenth century the art had almost died out of existence.

In 1872, some ladies of rank, with H.R.H., the Princess Christian of Schleswig Holstein, at their head, founded the School of Art Needlework, in Sloane-street, "for the twofold purpose of supplying suitable employment for gentlewomen, and restoring ornamental needlework to the high place it once held among the decorative arts." The school was removed to its present premises in Exhibition-road, in 1875, when the Queen was pleased to grant the prefix "Royal" to it. Lady Marian Alford, the vice-president, has described how the founders had first to teach themselves, and how much they learnt from the exhibition of the needlework of all ages at the South Kensington Museum in 1872. She writes, "Some of our difficulties lay in the catholic and universal nature of our attempts. We tried to work in Gothic, Renaissance, Plateresque, and Moorish, Elizabethan, Jacobean, and even Georgian styles, Henri II., Louis XIV., Louis XV., Louis XVI., all distinct and requiring each a life-long study. We have worked in silk, velvet, thread and crewels on silk, satin and linen, and executed *appliqué* in all the styles that have prevailed since style first began." In December, 1875, the numbers in the school were 110 workers and 20 staff, making 130 in all, and it has continued to prosper. Work to the value of upwards of £2,000 was sent to the Centennial Exhibition of Philadelphia in 1876, and a collection of embroideries was also sent to the International Exhibition at Paris in 1878. Agencies have also been opened in several large towns. Still further to cultivate an interest in the history of the art among the public, a special exhibition of ancient English and other art needlework made before 1800, was organised by the school, and opened on the 28th of last month. Before alluding to some of the chief objects exhibited, we quote a few words from Lady Marian Alford's address (1875) on the history of needlework. She writes, "We have no fragments of classical embroideries, but though the stitches have escaped us, we have the materials employed—the gold, silver, and wools; we know their designs from frescoes, fictile vases, &c. What strikes us particularly is, that the forms are so fine, so graceful, so exquisitely simple, never naturalistic, and mostly similar to those employed in architecture. I said before that we have nothing of classical needlework; our earliest European specimens come out of the shadow of the dark ages, and are of the ninth and tenth centuries. They are all ecclesiastical, with one or two exceptions, such as the Bayeux tapestry, and all ugly. . . . Undoubtedly, the greatest teachers of embroidery have been the Persian, Indian, and Moorish schools. These influenced the Italians in their design and colouring; and there is another Oriental group, the Chinese and Japanese, very clever and inimitable in their own distinct lines, but far inferior to the first named, in splendour of colour, power of composition and combination, and in that simplicity and yet effectiveness which is sometimes the highest art. In the exhibition of embroidery, at the Kensington Museum, all these types were well represented, and one thing was worthy of note; after a little study, you found that you could almost always assign its place to each piece of work, and put the right date on it, as surely did the stitch and manner betray the period, as surely as the shadow on the dial marks the time of day."

Formerly, the chief demand for art needlework was from the church, and almost all the specimens of the twelfth, thirteenth, fourteenth, and fifteenth centuries, at the recent exhibition, were ecclesiastical work. The late Dr. Rock wrote of ecclesiastical vestments in England—"No kingdom in Christendom was better furnished with them, and their tissues were of the most beautiful and costly that might anywhere be found; ciclatoun, and baudekin, and every other cloth of gold, either plain or shot with colour, samit and satin, velvet, as soon as it was known, silks after all fashions, damasked, rayed, watered, clouded, or as the term then was, marbled; cloth of Tarsus, and fabrics from Saracenic looms were brought from afar, and put to the service of the liturgy as they came to hand." Some of the finest specimens exhibited were lent by the South Kensington Museum, one of these being the famous Sion cope, which is dated about the year 1250. Besides several copes, there were chasubles, dalmatics, maniples, corporals, and altar cloths. Much elaborate work was at one time lavished upon hearse-cloths or funeral palls:—

> "Each virgin soon apply'd
> Her ready skill, and wrought of golden thread,
> A costly net, which o'er a pall they spread
> Of finest silk." *

Most of the City companies had their palls, which were lent out for the burials of their members and members' wives. One of these, belonging to the Vintners' Company, was exhibited.

At the Reformation, the ingenuity of the ladies was diverted into entirely new channels, and embroidery was used for a very large number of varied objects. Although in the work of the previous centuries there was necessarily a considerable variety of stitch, still the general design remained somewhat similar, as the objects to be ornamented continued the same, but when the needle was free to work for secular objects, a considerable change in treatment became perceptible, and the subjects were adapted to the objects treated. In the reigns of Henry VIII., Mary, and Elizabeth, a very favourite covering for books was embroidered velvet, and this taste was continued for long after their reigns. There was at this Exhibition a Prayer-book and Bible in red velvet covers, embroidered in gold and silver

* Hoole's translation of "Orlando Furioso," B. xxii.

thread work in relief, with the royal arms, rose and thistle, and C.R. (Charles I.). The nieces of Nicholas Ferrar, who lived at the manor house of Little Gidding, Huntingdonshire, called by the common people the Protestant nunnery, were great proficients in the art of needlework, and they produced a large number of embroidered covers for books, besides many other beautiful objects. Some years ago, three fine portraits in needlework, by these so-called nuns of Little Gidding, were exhibited at the Ironmongers'-hall. One of these was of the Virgin Mary, represented as "Queen of Heaven," in an oval wreath, at the angles of which are the pomegranates of Aragon. The second was a portrait of Edward VI., six inches square, and the third a portrait of Queen Elizabeth, of the same size as the second. The greater number of articles exhibited by the School of Needlework in illustration of the work of the sixteenth, seventeenth, and eighteenth centuries are wearing apparel, but in the eighteenth century there were several specimens of embroidered and painted silk and satin work, which were copies of engravings or pictures. In the sixteenth century, English ladies were famous for working carpets, which were used for hangings and table-covers. In 1548, George Lord D'Arcy left to his daughter Agnes, wife of Sir Thomas Fairfax, his "best wrought silk carpet, bordered with crimson velvet, which she made," and Sir William Drury, of Hawsted, County Suffolk, bequeathed to his wife, Elizabeth, "one carpitt for a cupboard, of those which were of her own making." In addition to the old English needlework, which formed the bulk of the Exhibition, there were some selected specimens of the chief European nations, besides a few pieces of Turkish, Japanese, and Persian work.

GLUCOSE MANUFACTURE.

The following particulars respecting the glucose industry, which has grown to large proportions in America during the past fifteen years, are obtained from the *Journal of Applied Science*:—There are at present ten glucose factories in the United States, running day and night, consuming 21,000 bushels of corn per day, each bushel yielding, on an average, 28 pounds of glucose. These figures would indicate a yearly production of over 200,000,000 pounds. That the business is a profitable one, would appear from the fact that it has at least doubled every year for the last five years. Large quantities of the products of the glucose factories are now exported to Europe, manufactories being able to furnish a cheaper and superior article to that made abroad from potatoes.

The principal object of the originators of this industry in the United States, we are informed, was to manufacture syrup, and from this the application of the products have widely extended. The glucose syrup is not so sweet as cane syrup, and has a lighter colour; and when mixed with the latter it improves its colour, though the saccharine strength or sweetness is impaired. The use of glucose for this purpose has come to be very general, and though even at the present time the business is largely conducted in a surreptitious manner, there are some manufacturers who openly acknowledge that they employ glucose in their syrups, and defend its use for that purpose.

The glucose is likewise largely used by brewers, distillers, and vinegar makers; for sizing paper, for making printers' inking rollers, and other uses. The grape sugar, under which term the manufacturers designate the solid portion of their product, is known to have been for some years quite largely used by confectioners, brewers, and others. Now, however, it is added in the proportion of from 12 to 20 per cent. to cane sugar, and in this form the mixture is brought into the market under the mame of "New Process Sugar." As in the case of the corn syrup, the addition of corn sugar to the cane sugars distinctly improves the colour of the latter, while it decidedly reduces its sweetness, which is of course the real test of the value of either syrup or sugar. By these explanations it will have been made apparent that colour, which has hitherto been regarded as one of the indicators of the quality of saccharine products, can no longer be so regarded.

The enormous growth of the business of making syrup and sugar for corn has awakened the very natural suspicion that these products are extensively used for adulterating cane syrups and sugars, and sold for the latter; and there is little doubt but that this species of falsification is carried on, though to what extent it is impossible at present to say. Corn sugar and syrups are not unwholesome; on the contrary, they may be looked upon as quite as wholesome as cane sugar and syrup. The fraud comes in where the corn products, which are cheaper and of less saccharine strength, are palmed off upon the public for what they are not.

HEMP CULTIVATION IN MEXICO.

The hemp industry in Mexico has, within the last ten or twelve years, attained considerable proportions, and one of the chief articles of trade in Yucatan, is the fibre extracted from the hemp plant, or American aloe, commonly called by the Indian name of "henequen." Consul Lespinasse states that the plant is found in profusion throughout Yucatan, and forms the nucleus whence all the present hemp plantations have been formed. The hemp tracks are divided into "meccates," which is a Mexican measure of 24 yards square. After all the shrubs and weeds have been burned during the previous dry season, the Indian labourers proceed to dig small pits, in a straight line, from six to eight feet apart, and between each line of pits, a path about nine feet wide is left clear, in order to give the labourers sufficient room to cut the leaves when they have attained their full growth. As soon as the required quantity of land is thus laid out, the young plants are cut close to the ground, and, without any further process, are simply placed in the pits prepared for them, with a little loose earth, and are left to take care of themselves. Each "meccate" contains about 96 plants. Twice a year the ground is cleared of the underwood. As the plant grows, a stem shoots out from the centre, and the leaves gradually detach themselves from it in a spear-like form, with sharp prickles along the edges, and a strong, black, sharp needle-like thorn at the point. The plant requires from five to seven years to attain its full growth. At the end of this period, the leaves have an average length of four feet. A hemp plant will flourish from 10 to 15 years. Each plant has about 26 leaves during the year, 16 in the rainy season, and 10 in the dry; each leaf, four feet long, produces about three-quarters of an ounce of fibre; it requires, therefore, from seven to eight thousand leaves to make a bale, weighing four hundred pounds. As soon as the plant has attained its full growth, the leaves are cut from the trunk, commencing from the bottom upwards, only those being cut which are well developed. From the hemp beds they are carried to the scraping-machine, which consists of a strong fly-wheel, on which six or eight blunt brass knives are placed transversely. The leaves are placed one by one on a curved lever, which is raised or lowered in such a manner that the knives on the wheel only strike the pulp and lay bare the fibre. First, one end of the leaf is presented to the wheel, and as soon as it is scraped the other end is presented. Each time one end is introduced, the other is secured by a strong pair of iron pliers, which are attached to the machine. Each machine employs four men, one to place the leaves near the machine, one to attend the lever, one to introduce the leaves into the machine, and the fourth to carry away the pulp and refuse matter. As a rule, the

machines are worked by steam-power, and can clean about four hundred pounds of fibre in one day. When the fibre is extracted from the leaf, it is taken to the drying-yard and hung on slender poles, which are stretched on wooden frames about three feet from the ground, and left to dry and bleach in the sun. If the weather is fine, it will become dry in four to five hours. While drying, the fibre loses its natural greenish hue, and assumes a white, glossy appearance. It is then placed in hydraulic presses, and compressed into bales of the required size, which generally weigh three hundred and fifty, four hundred, and five hundred pounds. The fibre is then ready for shipment.

SUGAR INDUSTRY IN QUEENSLAND.

From a report on this subject by Mr. Henry Ling Roth, it appears that the crops of sugar in this colony amounted in 1879 (that is 31st April, 1879, to 31st March, 1880) to about 18,200 tons, or about 4,500 tons above that of the previous year. The approximate output of the four sugar districts was:—

Southern district	about	2,200 tons.
Central ,,	,,	5,750 ,,
Mackay ,,	,,	9,500 ,,
Cardwell ,,	,,	750 ,,

The output for 1880 is estimated at 21,000 tons, which is considered a low estimate. As far back as 1823, the late Mr. Thomas Scott grew the sugar cane successfully under the patronage of Sir Thomas Brisbane, then Governor, and succeeded in obtaining 70 tons in 1827, at Port Macquire in New South Wales. This venture was carried out with the aid of convict labour placed at Mr. Scott's disposal by the Governor, but, on the removal of Sir Thomas, the sugar establishment was broken up. Various attempts were subsequently made to establish the sugar industry without effect. Throughout Moreton Bay, previous to its separation in 1859 from New South Wales and its formation into Queensland, the sugar cane was cultivated in the gardens of several people, so that there was little doubt as to the possibility of its culture.

The first sugar known to have been produced in Queensland was made by Mr. Buhôt, of Barbadoes, from cane grown in the Botanic Gardens, Brisbane, in May, 1862. In 1863, Captain L. Hope had twenty acres under cane, and the Society of Arts offered a medal for the first ton of sugar made in any of the colonies. By the end of 1867, there were 20,000 acres under cultivation for cane, and the six mills in existence manufactured 168 tons of sugar. At the close of the season of 1869 there were 28 mills at work crushing the cane from 1,230 acres, out of over 5,000 acres under cultivation. In 1875, the season turned out very bad, the cane, nearly drowned in wet, became unhealthy and died, giving next to no returns. In the course of time the evil effects of 1875 passed away, and the sugar industry has been since then, more or less of a success. The average yield of sugar per acre, in Queensland, for the ten years ending 31st March, 1879 (and including the rust year 1875), is as follows:—

	cwt.	qrs.	lbs.
Southern district	24	0	25
Central ,,	24	2	9
Mackay ,,	27	0	23
Cardwell ,,	30	1	2
Queensland ,,	25	3	0

These figures may be compared with the yield of other countries, as in the following table:—

Country.	Average yield per acre. lbs.
Demerara	4,480
Louisiana	1,200
Mauritius	3,500 to 5,500
Jamaica	1,344
Philippine Islands	2,800 (This has been stated as only 1,680 lbs.)
India	896
Rio Janeiro	2,100
Java	about 3,360

Mr. Roth writes respecting these figures:—"According to Porter, virgin land used to give 5,000 lbs. of sugar per acre, and Edwards, in his 'History of the West Indies,' speaks of soil in Jamaica, which with plant cane will produce $2\frac{1}{2}$ tons (5,600 lbs.) of sugar to the acre. Now, in Queensland, $3\frac{1}{2}$ tons and over, or above 7,840 lbs. per acre, have occasionally been obtained from soils newly broken up, but such a yield is exceptional." The manufacture of rum has increased at the same rate as that of sugar. The total production since 1867 was 1,842,322 proof gallons. Up to 1876, the yield was at the rate of over 2 gallons of molasses fermented to 1 proof gallon of rum distilled. For 1877, it was at the rate of $1\frac{4}{5}$ to 1, and in 1878, at the rate of 2 to 1.

The mean consumption of sugar in Australasia is greater than in any other part of the world. The consumption of sugar and molasses in England for 1878 was at the rate of $62\frac{1}{4}$ lbs. per head. Australasia, however, consumed 78·7 lbs. per head, or 16 lbs. per head more than England did. Of the colonies, Queensland is the greatest, and South Australia the smallest consumer, their consumption being 92·13 and 71·31 lbs. respectively. Australia draws her supplies from various quarters. Of the 91,500 tons which went into consumption in 1878, one-sixth was produced by Queensland, and one-twelfth by New South Wales, thus one-fourth of the sugar consumed in Australasia is produced in Australia itself. The remaining three-fourths are imported chiefly from Java and the Mauritius, supplemented by small supplies from the minor sugar-producing countries.

A WHOLESOME HOUSE.

"F.R.C.S." has written a letter to the *Times* under this heading, which contains a narrative of his efforts to convert an old London house into a perfectly wholesome and comfortable habitation. His first work was to empty and fill up the cesspools, over which he was living, and connect the home with the street sewer, which had not previously been done. The writer says:—"I had furnished the house in the way common to habitations of its class. There were window curtains in the dining-room, window curtains in the consulting-room, window curtains in the drawing-room, window curtains in the bedrooms. There were carpets on all the floors; there were unprotected papers on the walls; there were wardrobes and other pieces of furniture, which had their apparent height increased by cornices, within which were hollow spaces, seemingly made on purpose to form harbours for dirt. There were ponderous book-shelves, containing a formidable amount of printed lumber, and a still more formidable amount of dust. The walls were old, with uneven surfaces, and to these uneven surfaces dirt clung with an almost touching tenacity. There were all sorts of fluffy things about, which were supposed to be ornamental, fancy mats and the like, and which blackened the fingers of any one bold enough to touch them. Last, but by no means least, there were the ever-increasing accumulations of rubbish, such as old clothes, old toys, old books and pamphlets, old newspapers, old music, and miscellaneous trumpery of every description. Upon all these things the dirt of a London street poured in without intermission. In dry weather the dust found its way through every chink; in wet weather the feet of visitors brought in mud, which dried into dust speedily. If the children romped for ten minutes in a carpeted room, the dust would lie in a thick layer upon the tables and chairs

when they had finished. Dirt seemed to be omnipresent and all pervading. It was plentiful in the air we breathed, it mingled with the food we ate, and with the liquids we drank. The principle upon which I started was that the house, for the future, should be kept wholly free from superfluous contents, that all dirt-traps, whether fixed or movable, should be abolished, and that all surfaces should be rendered washable. The first thing was to send away cartloads of the varied material which I have already described as rubbish, the terms including all carpets, all window curtains, all the muslin blinds which people hang across the lower halves of bedroom windows, all books and pamphlets which were not really required, all antimacassars and the like, everything that was broken, and everything that was useless. Having thus cleared the ground, I commenced the work of reform. The first thing, of course, was to see carefully to the drainage and water arrangements, to the ventilation of soil-pipes, the condition of cisterns, and so forth; but in these respects there was not much to be done. The next thing was to cover the old floors with thin oak parqueterie, both in living-rooms and in bedrooms. Upon the parqueterie floors I have a few small Oriental rugs, each of which can be taken up and shaken in one hand. The next thing was to have every unfixed wardrobe, sideboard, or other piece of heavy furniture placed upon castors, so that it might be easily moved by the housemaids, and the wall and skirting behind it kept free from dirt. At the same time the top of every wardrobe and cupboard was levelled by a cover of thin planking or of stretched canvas covered by brown paper, so that all these surfaces could be wiped down frequently and kept perfectly clean. The painted woodwork generally was not only painted, but also varnished; and the wall papers were all varnished, with the exception of one, which was painted. Ventilation is provided for, both in sitting-rooms and bedrooms, by that old system of vertical tubes communicating directly with the outer air, to which attention was recalled some few years ago by Mr. Tobin. Outside the house the external portions of these tubes are bent vertically downwards for a few inches, a method by which the quantity of air-borne dirt which would otherwise enter through them is very materially diminished. In the dining-room the tubes are brought up through ornamental cylinders of Doulton ware resembling vases, but made for the purpose without bottoms, and placed upon wooden plinths of similar construction. In the bedrooms the surfaces of the tubes are painted the colour of the adjacent woodwork; and in some of the upper rooms I have been content with a simple board, about 5in. high, covering the lower part of the window opening, and serving to direct the entering air upwards when the sash is raised to a somewhat smaller extent. With this board the bedroom windows may be left open all night, both rain and direct draught being excluded."

In conclusion, "F.R.C.S." says that he wishes to pay a grateful tribute to Mr. R. W. Edis, from whose Cantor Lectures, delivered before the Society of Arts in 1880, he derived the suggestions which first led him to think of perfect cleanliness as the highest domestic virtue.

SWISS CENSUS OF 1880.

The Geneva Correspondent of the *Times* gives the following particulars respecting the recent census of Switzerland, of November 30, 1880. The population of Switzerland on the night of November 30, as given in the official returns, amounted to 2,831,787. In 1870 it amounted to 2,655,001; in 1860, to 2,510,794; in 1850, to 2,390,116. Hence in the first of these decennial periods (1850-60) the yearly increase was 11,219, in the second 14,494, in the third 17,679. In 30 years the population has increased 441,671, equal to an average of 14,387 a year. As may be supposed, the rate varies greatly in different parts of the country. In some cantons there has been a decrease. One canton, Aargau, shows a falling-off in every decennial period since 1840, except in the ten years between 1860 and 1870, and its population is now less than it was 30 years ago. The cantons wherein populations have most increased are Basel city, Uri, Zug, Neuchâtel, and Geneva. The population of Basel has risen from 29,555 in 1850 to 64,207 in 1880, an augmentation which is explained by its proximity to Germany and the number of German refugees who have taken up their abode in the district. An analogous cause, the nearness of Geneva to France, accounts in great part for the fact that the population of this canton has grown from 63,000 in 1850 to 99,000 in 1880. For although many French exiles have taken advantage of recent amnesties to return to their own country, not a few have formed connections and attachments in the neighbourhood, and will probably remain there all their lives, the more especially as by doing so they avoid, as well for themselves as their children, the burden of compulsory military service. The increase in the population of Uri and Zug arises from the presence in those cantons of workmen and others employed on the St. Gothard railway works. The increase of population in Switzerland at large during the 30 years ending 1880 has been at the rate of 5·50 per 1,000 per year. For the first half of the period in question the increase was rather under this proportion, for the second half rather over. Compared with the rate of increase in other countries, the rate in Switzerland is far from being high. Thus the rate per year per 1,000 in England is 13; in Scotland, 9·3; in Denmark, 11·1; Sweden, 11·5; Norway, 8·6; Prussia, 10; Saxony, 15·6; Holland, 9·5; Belgium, 8·2; Italy, 7·1. There are only three European countries in which the progress of population is slower than in Switzerland, namely, Bavaria, 5·4; Ireland, 4·6; and France, 2·3. The natural growth of the population of the Confederation in the time under review—that is, the excess of births over deaths—was 200,828; but as the actual increase was no more than 176,786, it follows that the country lost 24,112 individuals by emigration. The real loss, however, was probably not so great as these figures might seem to imply, for when the census of 1870, the basis of the comparison, was taken, some thousands of French people, the remnants of Bourbaki's army, French refugees and others, were included in the count. The report from which I quote enters into a curious calculation as to the economic effect of movements of the home population. For instance, between 1870 and 1880, Aargau lost by migration the whole of the natural increase of its population; in other words, although the births exceeded the deaths by 19,000, the population diminished by 400. The population of Zurich increased over and above its natural increase about 13,344, many of the new-comers being natives of Aargau. As young people in Switzerland do not move about much until they have finished their schooling, it is safe to conclude that the immigrants were on the average at least 16 years old. Taking one year with another, it is assumed that a child cannot be brought up to its 16th year for less than 1,800 francs (£74), which, seeing that the basis of the calculation is only £4 15s. 10d. a year, cannot be considered an excessive estimate. But as those 13,364 grown children were the survivors of 19,000, all of whom have cost something, it is considered that the total cost of their rearing ought to be put at £103 4s. 2d. each. Hence Zurich by this, so to speak, unearned increment of its population made a gain, or an economy, of 34,479,000 francs (£1,380,000) at the expense of Aargau and the other districts that may have contributed to the increase. If we assume, on the other hand, that the migrating Aargauers went to the United States, and adopt the American estimate, which fixes

the economic equivalent of every new-comer at 800 dols., the United States would be indebted to the little canton of Aargau, with its 198,000 inhabitants, for an addition to the national wealth, between 1870 and 1880, computed at £2,120,000. According to a return lately presented to the Federal Council, the *elite* of the army (or militia in regular training liable at any time to be called out for active service) is composed of eight divisions, with an effective strength of 117,759 men. The weakest of these divisions is 11,745, the most powerful 17,052 strong. The landwehr, who, having gone through a regular course of drill, are mustered for annual inspection only, made an effective force of 92,736. Hence, in case of need, Switzerland could summon to the field fully 200,000 men, all fairly disciplined, and many of them first-rate shots."

THE WAX PALM IN PERNAMBUCO.

Mr. Francis T. Eaton sends some further particulars respecting this palm, described in the last number of the *Journal* :—

Carnauba, or vegetable wax (not Camanba) is the produce of the leaves of the Carnauba Palm (*Corypha cerifera* ; natural order, *Palmaceæ*), one of the finest palms of the Brazilian forests. Its fan-like leaves are placed in a tuft at the top of a hard solid stem, growing from 30 to 40 feet in height, the stalks of the leaves themselves being 6 or 8 feet in length. When the leaves have attained perfection, they are found to be varnished with a thin coating of vegetable wax ; they are then gathered and laid in a cold dry place on cloths, where they naturally wither and shrink. In consequence of the shrinking, the coat of wax cracks, and peels off in small flakes ; these are from time to time collected, and it is turned out when melted into small earthen pans, and then cooled. The lumps (as imported), are about 3 and 4 lb. each, and bear the shape of the pan in which they have been melted ; it is of light sulphur colour, with a lustre between that of wax and rosin, and rather brittle. There were imported into Liverpool, in 1878, 80 tons ; in 1879, 13 tons ; and in 1880, 40 tons, and the value has ranged between 35s. and 85s. per cwt.

GENERAL NOTES.

Patent Museum.—Mr. Albert Grey, M.P. for Northumberland, has given the following notice :—"On going into Committee of Supply in Civil Service Estimates Vote 20 (Patent-office), to draw attention to the inefficient accommodation now provided for the Patent Museum at South Kensington ; and to move that the time has come when a building worthy of the nation, and calculated to promote the manufactures of this country, should be erected out of the surplus funds that have been derived from taxes on invention." From Mr. J. Howard's return, ordered 21st June, 1800, it appears that the excess of receipts over expenditure has been since 1868 to 1879 upwards of £1,275,569.

Land Reclamation in Florida.—It is reported in the *Engineer* that the Philadelphia capitalists who are about to reclaim the immense tracts of land in the State of Florida known as the Everglades, have completed their contract with that State, one of the main features of the scheme being the building of a ship canal across Florida. This project almost equals in importance that of reclaiming 12,000,000 acres of rich land. It would not only shorten the distance between the American ports on the Atlantic coast and all European ports to New Orleans, Mobile, and all shipping points on the Gulf of Mexico, but it would avoid the dangers to navigation which are experienced on the countless keys and coral reefs off the southern and south-western coast of Florida.

Sanitary Exhibition.—The allotment of space in the International Medical and Sanitary Exhibition to intending exhibitors is being proceeded with, and at the last meeting of the committee the names of 225 exhibitors were registered and approved as follows:—Medical section, 115; sanitary section, 94; miscellaneous section, 16. In addition to the wall space and counter space taken, upwards of 1,200 feet frontage of floor space will be allotted to the above exhibitors, representing an area of no less than 8,000 square feet. This area will be occupied by articles which are said to be strictly within the object of the exhibition. The list of exhibitors already includes the leading manufacturers in Great Britain and Ireland in connection with the medical industries, and the industries connected with architecture and sanitary engineering, and important exhibits are said to be announced from France, Germany, Austria, Italy, Belgium, Holland, Norway, and the United States. The time for receiving applications for space came to an end on Saturday last, 16th inst.

Resistance to Bending of Tempered Glass.—At a recent meeting of the Académie des Sciences, M. de la Bastie communicated some data as regards the resistance to deflection of tempered as compared with ordinary glass. It appeared from a first series of thirty-six experiments that :—(1) The elasticity is more than doubled in the tempered glass ; (2) single tempered glass possesses a resistance about two and a half times greater than ordinary double glass ; and (3) semi-double tempered glass is about three times stronger than ordinary double glass. A second series of forty-three experiments showed that :—(1) While the deflections assumed by ordinary glass are so slight that they cannot be registered, tempered glass deflects to an appreciable extent under a load ; (2) tempered plate-glass, varying in thickness from 6 to 13 millimètres (about a quarter to half inch), possesses a resistance 3·67 times greater than that of ordinary plate-glass of equal thickness ; (3) tempered unpolished glass is about 5·33 times stronger than ordinary unpolished glass.

Tobacco from China. — In his last report from Hankow, her Majesty's Consul writes that the supply of tobacco is so large from the provinces of which the mighty Yangtsze-kiang forms the market-road, and the leaf so fine in colour, texture, and fragrance, that merchant after merchant has felt convinced that it ought to form a profitable export ; but, though in past years it was sent to America to aid in the manufacture of Havanas, and also to England for similar purposes, it has not until quite lately proved a remunerative investment. It is now, Mr. Alabaster believes, used for the manufacture of cigarettes, under the name of Turkish tobacco, and for mixing with various cut tobaccoes in this country ; but he goes so far as to express his conviction that, when better known, it will be smoked on its own merits. Mr. Alabaster only refers to the unprepared leaf-tobacco, as the prepared article, from the nature of the process it goes through, has a taste somewhat nauseous to the foreign palate. In twelve months, close upon eight million pounds of this leaf tobacco were exported from Hankow in foreign bottoms alone, without taking into consideration the amount shipped in native junks ; the estimated value being given at about £120,000.

Cost of Electric Lighting.—The following particulars of the cost of electric lighting in the City are given in the *Citizen*. In the district allotted to the Anglo-American Electric Light Company (Brush light), comprising Blackfriars-bridge, New Bridge-street, Ludgate-circus, Ludgate-hill, St. Paul's Churchyard, Cheapside (western end to King-street), 32 electric lamps, at a cost for the year of £1,410, are substituted for 150 gas lamps, costing annually £650 (including lighting and cleaning), thus making the cost of the experiment in this district but £760 above the ordinary outlay for gas ; but, deducting the cost (estimated at £750) of providing and fixing the electric machinery and lamps, and removing the same at the expiration of the contract, the expense, as near as possible, is the same as for gas. In the district comprising London-bridge, Queen-street, King-street, Poultry, Guildhall-yard, Mansion House-street, Royal Exchange, and King William-street, assigned to Messrs. Siemens Brothers, 32 electric lamps (including six large ones) will be employed in lieu of 138 gas lamps. The amount of this contract is £3,720. The sum saved by non-consumption of gas is about £600. The amount estimated for providing and removing the electric machinery and lamps at the expiration of the contract is 1,450, so that the cost, compared with gas, is 3⅔ more.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

April 27.—"Five Years' Experience of the Working of the Trade Marks' Registration Acts." By Edmund Johnson. Theodore Aston, Q.C., will preside.

May 4.—"Buying and Selling; its Nature and its Tools." By Professor Bonamy Price, M.A. Lord Alfred S. Churchill will preside.

May 11.—"The Manufacture of Glass for Decorative Purposes." By H. J. Powell (Whitefriars Glass Works). William Spottiswoode, LL.D., P.R.S., will preside.

May 18.—"The Electrical Railway, and the Transmission of Power by Electricity." By Alexander Siemens. Dr. Siemens, F.R.S., will preside.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

May 10.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

April 28.—"Impurities in Water, and their Influence upon its Domestic Utility." By G. Stillingfleet Johnson, F.C.S. Allen Thomson, M.D., F.R.S., will preside.

May 12.—"Recent Progress in the Manufacture and Applications of Steel." By Prof. A. K. Huntington.

May 26.—"Telegraphic Photography." By Shelford Bidwell. Prof. W. G. Adams, F.R.S., will preside.

Indian Section.

Friday evenings, at eight o'clock:—

April 29.—"The Building Arts of India." By General Maclagan. Andrew Cassels, Member of the Indian Council, will preside.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Four Lectures.

Syllabus of the Course.

Lecture III.—May 2.

Fringes. Twisted thread-work in England in the 15th century. Early designs for plaited and twisted threads. Italian, Flemish, French, and English pillow lace. Laces of primitive design.

Lecture IV.—May 9.

Resumé as to styles of design in hand-made lace. Traditional patterns. Sketch of the development of inventions for knitting and weaving threads to imitate lace. Differences between machine and hand-made laces. Modern hand-made laces at Burano, Bruges, Honiton, &c.

This course will be illustrated by specimens of lace. Diagrams and photographs enlarged will be shown by means of the lantern and oxyhydrogen light.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures. May 16, 23, 30.

Admission to Meetings.

Members have the right of attending all the Society's meetings and lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

Monday, April 25th...British Architects, 9, Conduit-street, W., 8 p.m. Mr. J. Slater, "Electric Lighting applied to Buildings."
Institute of Actuaries, The Quadrangle, King's College, W.C., 7 p.m. Mr. Harald Westergaard, "Notes on the Mortality of the Danish Clergymen from 1650 to 1818."
Medical, 11, Chandos-street, W., 8½ p.m.
London and Middlesex Archæological Society, 4, St. Martin's-place, W.C., 8 p.m. Rev. H. Clutterbuck, "A Dismal Depression in Drapery, 1622."

Tuesday, April 26th...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Non-Metallic Elements." (Lecture I.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Walter R. Browne, "The Relative Value of Upland and Tidal Waters in producing Scour."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.

Wednesday, April 27th...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Edmund Johnson, "Five Years' Practical Experience of the Working of the Trade Marks' Registration Acts."
Geological, Burlington-house, W., 8 p.m. 1. Mr. D. Mackintosh, "The precise mode of accumulation and derivation of the Moel Tryfan Shelly Deposits; on the discovery of similar High-level Deposits along the eastern slopes of the Welsh Mountains; and on the existence of Drift-zones showing Probable Variations in the rate of Submergence." 2. Mr. E. Willett, "Notes on a Mammalian Jaw from the Purbeck Beds at Swanage, Dorset." 3. Rev. J. F. Blake, "The Correlation of the Upper Jurassic Rocks of England with those of the Continent." 4. Mr. A. W. Waters, "Fossil Chilostomatous Bryozoa from the Yarra-Yarra, Victoria, Australia."
Royal Society of Literature, 4, St. Martin's-place, W.C., 4½ p.m. Annual Meeting.
Sanitary Institute of Great Britain, 9, Conduit-street, W., 8 p.m. Resumed discussion on the Address by Dr. Richardson, "Suggestions for the Management of Cases of Small-pox and of other Infectious Diseases in the Metropolis and large Towns."
London Institution, Finsbury-circus, E.C., 12 noon. Annual meeting.

Thursday, April 28th...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Mr. G. S. Johnson, "Impurities in Water, and their Influence upon its Domestic Utility."
Royal, Burlington-house, W., 4½ p.m. 1. Mr. H. Tomlinson, "The Influence of Stress and Strain on the Action of Physical Forces." 2. Mr. W. K. Brooks, "The Metamorphosis of Lucifer: a Study in Morphology."
Antiquaries, Burlington-house, W., 8½ p.m.
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. J. R. Sawyer, "The Autotype Processes as Applied to Fine Art Reproductions."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Paramagnetism and Diamagnetism." (Lecture I.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.

Friday, April 29th...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) General Maclagan, "The Building Arts of India."
Zoological, 11, Hanover-sq., W., 1 p.m. Annual Meeting.
Royal Institution, Albermarle-street, W., 8 p.m. Weekly Meeting 9 p.m. Prof. Blackie, "The Language and Literature of the Scottish Highlands."
Geologists' Association, University College, W.C. Excursions to Charlton and Blackheath, under the direction of Dr. Logan Lobley.
National Health Society, 23, Hertford-street, W., 4 p.m. (Drawing-room Lectures.) Prof. Fleeming Jenkin, "Sanitary House Inspection."

Saturday, April 30th...Royal Botanic, Inner-circle Regent's-park, N.W., 2 p.m. Exhibition of Spring Flowers.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Henry Morley, "Scotland's Part in English Literature." (Lecture I.)

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, APRIL 29, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART WORKMANSHIP EXHIBITION.

The preparations for the Exhibition of Works of Art applied to Furniture, at the Royal Albert Hall, are now being proceeded with. The available space has been divided amongst the following firms, who will afford facilities to exhibitors of articles which may be considered as accessories of furniture, such articles to be shown in company with the specimens of art furniture exhibited:—Messrs. J. G. Crace and Son; Morant, Boyd, and Blanford; Jackson and Graham; Gillow and Co.; Holland and Sons; Howard and Sons; Wright and Mansfield; Collinson and Lock; Gregory and Co.; Shoolbred and Co.; and Johnstone, Jeanes, and Co. The Exhibition will open on Thursday, 12th May, at the same time as the General Art Exhibition at the Albert Hall, and it is proposed to keep the Exhibition open until the end of July.

DOMESTIC ECONOMY CONGRESS.

A meeting of the General Committee of Ladies of the above Congress was held at the Society of Arts on Wednesday, the 27th April, Sir Henry Cole, K.C.B., in the chair. Present:—The Countess of Airlie, the Viscountess Harberton, Lady Charlotte Schrieber, Lady Blanche Hozier, Lady Cole, Mrs. Cotton, Mrs. Floyer, Mrs. Grenfell, Mrs. Hollond, Mrs. Lecky, Mrs. Mann, Mrs. Peploe, Miss Cole, Miss Hooper, and Miss Fay Lankester. Lord Alfred S. Churchill, Major-General F. C. Cotton, C.S.I., Rev. J. Faunthorpe, and the Rev. Newton Price, members of the Executive Committee, were also present.

PROCEEDINGS OF THE SOCIETY.

NINETEENTH ORDINARY MEETING.

Wednesday, April 27th, 1881; Theodore Aston, Q.C., in the chair.

The following candidates were proposed for election as members of the Society:—

Allison, Herbert John, 41, Southampton-buildings, Holborn, W.C.
Baggallay, Henry Charles, 4, Ada's-avenue, Hull, Yorkshire.
Blakesley, John Holmes, M.A., 23, Fopstone-road, South Kensington, S.W.
Elliott, William St. George, M.D., 39, Upper Brook-street, W.
Favarger, Henri, 75, Turnmill-street, E.C.
Heseltine, Francis J., Westminster Palace Hotel, Victoria-street, S.W.
Inglefield, Admiral Sir Edward, K.C.B., 99, Queen's-gate, South Kensington, S.W.
Keefe, John, Colquitt-chambers, 6, Colquitt-street, Liverpool.
Longworth, William, Guildford, Surrey.
Matthay, George, F.R.S., Cheyne-house, Chelsea Embankment, S.W.
Ramsden, John Carter, Gristhorpe-hall, near Filey, Yorkshire.
Ravensworth, Earl of, 9, Mansfield-street, W.
Severn, Walter, 9, Earl's-court-square, S.W.
Snape, William, J.P. (Mayor of Over Darwen), Lynwood, Darwen, Lancashire.
Sproston, Hugh, Hughville, South Norwood, S.E., and Demerara.
Thornton, Edward, C.B., Bank-house, Windsor.
Warren, W. J., Cotford-villa, Bournemouth.

The following candidates were balloted for, and duly elected members of the Society:—

Culley, William Richard, 15, Maryon-road, Charlton, S.E.
Dale, George Williams Melville, Ellerslie, Nether-street, North Finchley, N.
Davis, Moses, 27, Wellclose-square, E.
Knight, William Duncan, Avening-house, Greenhill, Hampstead, N.W.
Mackie, John, 2, Victoria-villas, Queen's-road, Reading.
Pope, Joseph John, M.R.C.S., 4, South-crescent, Bedford-square, W.C.
Rowan, Arthur Hill, 6, Westminster-chambers, S.W.
Thornhill, George, C.S.I., 36, Eastbourne-terrace, W.

The **Chairman**, in introducing Mr. Johnson, said the subject of trade marks was one of great national, and even international, importance. The system introduced by the new law was entirely new, and the law itself in many points was defective, in not expressing what ought to be done in order to carry out its enactments. Much credit was due to Lord Cairns for the attention he paid to the subject, and the care with which the rules were drawn up, but the matter being entirely new, a great deal was left unprovided for, which experience had shown might and ought to have been enacted. If those present would, at the conclusion of the paper, favour the meeting with their suggestions as to what might be done to carry out the intention of the Act, they would render great service to the commercial community.

The paper read was on—

TRADE MARKS.

By Edmund Johnson, F.S.S., F.Z.S.

Honorary Secretary of the London Trade Marks Committee.

The law relating to trade marks is founded on an accumulation of judicial decisions of our Chancery Judges, based upon the common law of the land and on principles of equity; and was well established before the Trade Marks Registration Act of 1875 came into operation.

It cannot be too clearly stated that the object of the Act was not to interfere with existing rights or to alter the general law, but, as its name infers, to devise a system of registration for trade marks; and, incidentally, its effect has been to render registration compulsory, by debarring those owners whose marks were not registered before the 1st July, 1876, from the right to institute proceedings to prevent infringement.

I desire to confine my attention, as closely as possible, to the practical experience gained in connection with applications for the registration of trade marks under these Acts; and, in the course of these observations, I shall have occasion to mention some important and leading judicial decisions bearing upon the subject, and to suggest some alterations which, I venture to think, will meet with the general approval of those interested in trade marks.

The Act of 1875 provides for the establishment of a registry. It enacts, *inter alia*, that a trade mark must be registered as belonging to particular goods or classes of goods; that registration of a person as first proprietor of a trade mark shall be *primâ facie* evidence of his right to the exclusive use of such trade mark, and shall, after five years from registration, be conclusive evidence of his right to the exclusive use of such trade mark. Section 10 of the Act thus defines a trade mark:—

"For the purposes of this Act, a trade mark consists of one or more of the following essential particulars; that is to say:—

"A name of an individual or firm printed, impressed, or woven in some particular and distinctive manner; or

"A written signature or copy of a written signature of an individual or firm; or

"A distinctive device, mark, heading, label, or ticket;

and there may be added to any one or more of the said particulars any letters, words, or figures, or combination of letters, words, or figures; also

"Any special and distinctive word or words or combination of figures or letters used as a trade mark before the passing of this Act may be registered as such under this Act."

The Act also contains various provisions as to applications to the Chancery division, for rectification of the register and as to the framing and varying of rules.

The Amendment Act of 1876 extended the prescribed period for registration for one year, and introduced a very important new feature in providing for the granting of certificates of refusal in respect of such old marks as could not be registered under the Act of 1875.

The Act of 1877 extended the date for the registration of marks used in textile industries (Classes 23 to 35) to the 1st July, 1877, or such further date as might, by Order in Council, be determined.

Rules.—The first schedule to the Rules, settled and published by order of the Lord Chancellor, contains a list of the fifty classes into which goods are distributed for the purposes of registration, in one or more of which every mark must be registered.

The statement containing the application for the registration of a trade mark must specify the goods with respect to which the mark is to be registered, and in the case of a trade mark used before the passing of the Act, must particularise the goods in respect of which it has been used, and the length of time so used.

Other provisions are contained in the rules with reference to the advertisement of the application and notice of opposition, as to which I need not here make any special reference. I may simply remark that they are framed with ability, and have been carried out by the Trade Marks Registry in such a manner as to merit and secure general satisfaction.

Classification.—The classification of goods in respect of which trade marks are registered in the fifty different classes has been found on the whole to work well. It was prepared upon the basis of the system adopted in connection with most of the leading International Exhibitions. Some classes are very distinct in themselves, whilst others, necessarily, are somewhat incongruous.

The Registry.—On January 1st, 1876, the office for receiving applications for the registration of Trade Marks was opened at 4, Quality-court, Chancery-lane, under the superintendence of the Commissioners of Patents, Mr. H. Reader Lack, of the Board of Trade, a gentleman who had acquired much commercial experience during his many years' connection with that department, being appointed Registrar. Some time afterwards, Mr. J. Lowry Whittle, Barrister-at-Law, was appointed Assistant-Registrar, being subsequently succeeded by Mr. W McCalmont Cairns. The registry is now permanently established at the Patent-office, in Southampton-buildings.

Applications during the first year flowed in very rapidly. The number received up to December 31st, 1876, was 3,698, covering a total of 10,384 marks. Of these, 2,204 cotton marks were sent on to Manchester. 56 oppositions were made during the first year.

Marks were first placed on the register in October. The number of marks registered at 31st December, 1876, stood at 261, some of which being registered in more than one class, the total registrations attained was 454.

Meanwhile 47 numbers of the official paper, known as the *Trade Marks Journal*, had been issued. The first number was published on May 3rd, 1876. The *Journal* specifies the name and calling of applicants, the description of goods to which the marks have been or are to be applied, and, in connection with old marks, the length of time during which they have been used; such information is accompanied in every instance by an illustration of the mark, with the exception hereafter referred to. During 1876, 4,031 different marks were advertised, giving a total of 4,874 advertisements, many of the marks being applied for in more than one class.

Particulars of the marks registered are inserted in the *Journal*. The first list was given in No. 48, January 3rd, 1877. Every successive number has contained a list of the marks registered since the issue of the preceding *Journal*.

During 1877, the second year, the number of marks tendered for registration was considerably less, thus enabling much attention to be devoted to the marks left over during the preceding year, the registration of which accordingly proceeded with rapidity, 4,984 being placed on the register by the end of that year.

The experience brought to bear by this time also gave rise to many questions, in regard both to practice and law, which had to be settled by judicial decisions. Registration in connection with certain classes of marks necessarily had to remain in abeyance pending such decisions in the Courts of first instance. There were several appeals, and one case was taken to the House of Lords.

It was only after the great mass of marks in use in particular branches of industry had been brought together so as to permit of examination, that any comparison could be made in connection with what are recognised under the term of "private" and those known as "common" or "open" marks. This distinction is not confined to the cotton trade, although most conspicuously displayed in marks employed therein. It extends to other industries, among which may be specially mentioned the iron trade (in which arose the questions settled in "Barrows's case") and the needle trade.*

The number of marks advertised in 1877 was 7,907, as against 8,753 placed upon the register. Of the latter, of course, a large proportion included marks applied for during 1876.

In 1878, 3,240 marks were advertised, and 3,687 registered. In 1879, 3,198 were advertised, and 3,118 registered, against 2,417 advertised and 2,752 registered during 1880. The total numbers for the five years thus attained are 21,636 marks advertised, and 18,764 registered*.

* Mentin may be made of the following different modes of registration, *viz.*:—Representative registration, as in Barrows's case and Brooks's case, where an essential feature is registered, with an intimation that this feature is protected in a variety of combinations. Registration with a note appended, limiting registration in some way; *re* Mitchell (2); *re* Leonhardt; *re* Kuhn and Co.; ex *parte* Barrows; *re* Jelly, Son, and Jones; *re* Lysaght; *re* Rabone; *re* Farina (3); *re* Whiteley (all in Sebastian's Digest of Trade Mark Cases); *re* Sykes (29 W. R.) Registration of essential features only, as in Orr, Ewing *v.* Registrar of Trade Marks, in House of Lords. The decision of the Court of Appeal seems at variance with this decision when, in *re* Royal Baking Powder Co., they refused to register the word "Royal," or the words "Royal Baking Powder," without other details, though the word "Royal" was the only feature in the whole label that could be called distinctive, which, in this particular trade, it appeared to be.

* The following is a statement of the Number of Trade Marks Advertised and of the Number Registered in each of the 50 Classes of Goods, respectively, during the five years commencing 1st January, 1876, and ending 31st December, 1880:—

Class.	1876.		1877.		1878.		1879.		1880.		Total.	
	Advertised.	Registered.	Advertised.	Registered.	Advertised.	Registered.	Advertised.	Registered.	Advertised.	Registered.	Advertised.	Registered.
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
1	80	2	106	136	42	56	47	39	37	47	312	280
2	69	3	90	132	47	43	27	24	40	30	273	232
3	273	28	374	456	148	207	126	106	144	134	1,065	931
4	30	3	92	74	39	45	36	36	24	31	221	189
5	520	64	460	659	196	159	168	228	65	115	1,409	1,225
6	161	34	223	269	62	83	40	50	16	18	502	454
7	36	...	140	111	45	72	21	29	14	10	256	222
8	19	...	72	61	29	27	18	14	13	29	151	131
9	21	7	29	30	8	13	11	7	6	7	75	64
10	35	6	35	45	19	22	18	17	18	18	125	108
11	18	4	43	43	18	22	11	15	14	9	104	93
12	221	3	363	457	107	131	51	57	58	80	800	728
13	419	27	586	687	188	185	91	206	156	129	1,440	1,234
14	122	23	93	154	41	43	53	63	33	29	342	312
15	24	4	28	34	11	17	12	11	21	21	96	87
16	57	17	41	61	21	22	24	21	19	19	162	140
17	16	2	31	27	14	11	14	17	10	7	85	64
18	77	4	84	111	27	35	13	16	25	12	226	178
19	29	2	44	52	18	23	6	11	8	7	105	95
20	17	2	41	26	11	30	1	7	2	1	72	66
21	29	1	33	39	11	17	11	13	2	2	88	72
22	9	1	18	18	17	14	4	5	15	9	63	47
23	...	...	365	225	148	238	124	116	196	214	833	793
24	...	...	...	...	52	7	1,030	752	313	588	1,395	1,347
25	...	...	62	31	50	56	40	44	15	22	167	153
26	9	...	86	57	22	52	21	19	16	9	154	137
27	10	...	140	122	28	44	20	14	17	17	215	197
28	3	...	56	35	22	41	16	12	12	12	109	100
29	2	...	23	21	9	9	12	11	5	6	51	47
30	38	...	69	67	45	60	16	20	15	19	183	166
31	12	...	63	57	37	44	16	14	18	18	146	133
32	4	...	93	47	41	72	15	20	22	19	175	158
33	27	...	34	40	24	30	18	16	24	17	127	103
34	16	...	197	156	101	120	62	51	56	60	432	387
35	9	...	87	54	67	79	26	29	17	24	206	186
36	17	4	31	36	18	12	15	18	9	10	90	80
37	44	3	60	77	29	26	15	23	15	16	163	145
38	104	13	206	232	118	125	67	72	77	70	572	512
39	197	27	350	269	133	189	159	86	65	136	904	707
40	16	...	50	45	27	26	18	21	10	15	121	107
41	15	3	34	30	14	12	11	14	7	8	81	67
42	429	70	432	624	241	202	161	179	169	151	1,432	1,226
43	676	31	710	1,073	217	259	131	135	149	132	1,883	1,630
44	131	12	271	215	50	64	29	33	59	41	540	365
45	292	23	538	547	150	209	124	149	155	145	1,259	1,073
46	5	3	2	2	2	2	1	2	2	1	12	10
47	198	4	301	391	108	124	82	85	76	85	765	689
48	152	9	167	239	178	102	51	50	65	64	613	464
49	19	...	36	29	18	18	20	24	8	13	101	84
50	167	15	418	350	172	188	95	117	85	76	937	746
Total	4,874	454	7,907	8,753	3,240	3,687	3,198	3,118	2,417	2,752	21,636	18,764

During 1876, there were issued 47 numbers of the *Official Journal;* 76 in 1877; 33 in 1878; 27 in 1879; and 26 in 1880. The total for the five years is 209.

There can be no doubt that registration has had the effect of encouraging the adoption of new trade marks. This is shown by the fact that, whilst in the first six numbers of the *Official Journal* the proportion of old to new marks was 633 to 100, in the last six issued during the year 1880, there were advertised but 91 old marks against 365 new. As a matter of course it may be assumed that the bulk of the old marks, that is those in use at the passing of the Act (August 13, 1875), have been tendered for registration in the five years during which it has been in operation. Under the restrictions prevailing with reference to new marks, it may well be claimed that there is thus every prospect of ample distinctiveness in the trade marks of the future.

Oppositions.—In all, during the five years, 287 oppositions have been made. Of these, but a small proportion of cases have been carried into Court, a great number having resulted in compromises between the parties concerned, or by the withdrawal of the original applications.

Registration of Subsequent Proprietors.—Under assignment, and by transmission, 135 registrations have been effected during the five years. Some further provision on the subject seems necessary.

I am aware of an instance in which the agent in this country of a Continental manufacturer, under instructions to register a trade mark for his principal, completed the registration in his own name, not omitting, however, to debit the costs to the rightful owner of the mark. Subsequently, on the wrongful registration becoming known, the owner was content with the surrender of the notification of registration previously issued by the registrar, and an assignment of the mark itself. As to the value of an assignment under such circumstances, it is not for me to pronounce, but I venture to doubt whether the registration of what is not lawfully possessed can ever be valid, or any legal assignment of it possible.*

Certificates of Registration.—During the five years, 614 certificates for obtaining registration abroad have been applied for, and 86 certificates for use in legal proceedings. The facilities accorded in procuring foreign registrations have been found of much value in all instances, whilst in some countries, as is well known, registration of British trade marks could not have been otherwise obtained.

Certificates of Refusal.—Up to December 31st last, 212 such certificates had been issued. Athough this number is comparatively small, it must be admitted that the value of the certificate to the owners of the marks has in most instances fully warranted the providing for such certificates in the Amendment Act of 1876. I am not aware whether in foreign countries, where the certificate from the registry here is a *sine quâ non* to obtain registration by British manufacturers, the certificate of refusal is equally recognised. Certainly it should be so. The certificate of refusal is, as it were, a recognition of the user of the mark, with the official statement of the fact that the mark, although possibly a valid one, is not capable of registration here under the Act.

Searches.—The total number of searches and inspections at the registry during the five years was 4,801.

Rectification of Register.—In all, but 47 rectifications had been effected prior to December 31st last. This is not astonishing, for when the trouble and cost of an application to the High Court are considered, it may be well assumed that every effort is made to avoid recourse to such procedure, even when involving merely a consent brief. The registrar has the power at any stage during application, both before and after the advertising of a mark, to permit any alteration; but once placed upon the register, the mark passes wholly out of his control and into that of the Court. That this should be so in regard to the essential and distinctive features of the trade mark is undoubtedly reasonable; but that the registrar should not be empowered to make a mere verbal alteration in a registered mark which includes text, such as address, &c., can scarcely be deemed so. Under proper restrictions and the payment of proper fees no difficulty should be placed in the way of a registered owner making such slight alterations as may be required from time to time upon the register. This is a question which ought to be dealt with under a new rule, and I venture respectfully to submit it to the consideration of the Commissioners. That the full majesty of the Chancery Division of the High Court of Justice should have to be brought to bear, and its ponderous machinery set in motion, for a mere trifling alteration in an old label upon the register seems monstrous. In one instance, of recent date, the registered owner of three labels, desirous of striking out in one the word "manufactory," and to reduce the size of type in which his address appeared, and putting it in brackets, did actually apply to the Court for an order. Certainly, under the same motion, he rectified the register by striking out the words "prepared by" from a second label, altering the type and character of the address on it, and likewise obtaining authority to place it within brackets; and similarly to get rid of the word "manufactory" and vary the address in a third label, all for one set of costs. The object of such an application, doubtless, was to obtain certificates bearing the labels in the amended form for some foreign registrations. The applicant, as a matter of course, when registering abroad, would desire to protect his labels in the form in which they are now used in the country in which registration is sought. If he obtained the certificates under the original registration, the representations on the certificates would not correspond with the representations tendered for the foreign registrations. The application would be refused; and it so becomes necessary as a preliminary step to rectify the register here.

If a trade mark is incorrectly registered, any person who is aggrieved can apply to have the register rectified, and the mark removed in whole or in part, or a note appended limiting the registration in some way. The application

* See *ex parte* Lawrence, *re* Rust, and *re* Farina. 29 W. R.

may be made either on the ground that the mark is the property of the applicant, or that it is common property, and should not be registered at all. A good illustration of this class of cases is the sealing-wax case. Messrs. Hyde registered the words "Bank of England" as applied to sealing-wax; thereupon other makers of wax applied to the Court to rectify the register, by cancelling Messrs. Hyde's registration. They proved the use of the words "Bank of England" by others in the trade for upwards of forty years, and on this evidence the Master of the Rolls ordered the registration to be cancelled. In giving judgment he said:—

"It is incumbent on every one who disputes the title to a trade mark to apply as speedily as possible to remove the mark from the register. Those who register a mark to which they are not entitled, do so at their own risk and peril. They must satisfy themselves before they register that it is a mark to which they are entitled, and I do not see any reason whatever for drawing any distinction between one title and another. If a man has a good title he has a right to register, and if he has no title, he ought not to attempt it. As a general rule, it must be understood that every man registers at his own peril."

The law as to rectification has been summarised by Lord Blackburn.*

In several instances applications to the Court for rectification have been necessitated by the applicant partner having omitted to include the names of the other members of the firm in the original application, registration then being effected in the name of the applying partner as though trading alone in the name of a firm. The power of the Court to direct rectification in such cases appears to require enlargement.

Cancellations. — The new rule made on February 14, 1878, providing for the cancellation of entries upon the register by the proprietor, although utilised in only eleven instances, is a wise provision. Its utility has been found, in an instance within my own knowledge, in facilitating the placing on the register of the rightful owners of a foreign trade mark which had been inadvertently registered in the name of their British agent. The cancellation, in the first instance, and subsequent re-registration, have presented a simple mode of dealing with what otherwise might have involved an application to the Court, or other complicated procedure. Similarly, where errors in specifying ownership, or in the description of the trade mark, or the term of user, have unintentionally been committed in the original declaration, under this rule applicants who do not object to forego the advantages of the earlier date of registration can cancel and re-register at later date in a corrected form.

* "When the Chancery Division is satisfied that the applicant is a person who is for the time being entitled to the exclusive use of a trade mark in accordance with law, and that the trade mark is one within the definition of sect. 10 of the Act of 1875, the Court is *ex debito justitiæ* to rectify the register, just as it would before the Act of 1875 have been bound *ex debito justitiæ* upon similar proof to prevent any one infringing a trade mark then and still his property. The burden of proof lies upon the person making the application to amend the register, but if he does produce such proof as would in the opinion of the Court entitle him to an injunction, I do not think that the words of the 5th section, 'if satisfied of the justice of the case,' can or ought to be construed as meaning to give the Court a discretion to consider whether the nature of the trade mark is such as to make it inconvenient that he should exercise the right of property which it is proved he actually has."

Finance.—The total revenue received at the registry in respect of fees, certificates, searches, &c., for the five years amounts to nearly £30,000.* The cost of conducting the office has been considerably less. Judged by the practical value of the work done, this is not material. It is, however, a matter for consideration whether a department of this character should not be conducted wholly irrespective of the question of profit or loss. The fees fixed are moderate, and when it is borne in mind that no further revenue in respect of marks registered can be anticipated until the expiry of the fourteen years over which registration extends, a credit has to be taken from the funds meanwhile as it were accumulated, as against the cost of conducting the registry during so many subsequent years. In this manner it may perhaps be assumed that on balance at the expiry of the first fourteen years the registry will be found to have just paid its way as a department. This by many will be viewed with far more satisfaction than are the constantly accumulating profits of the Patent-office.

Definitions of Trade Marks.—All laws on the subject of trade marks and systems devised for their registration are founded on the ground common to all, viz., efficacious and economical protection.

In whatever country, therefore, trade marks are made the subject of legislative enactment, the definition of that which is to be protected—the trade mark itself—is of primary importance.

The initial difficulties which must encounter any attempt to establish an international trade mark law, will be found in the fact that each country has defined a trade mark according to its own prevalent ideas of what it should be, and not with the view of finding some definition which would be common to all countries.

For instance, in England the *fac-simile* of a signature is recognised as a trade mark. This is not so in America, unless the autograph has something to distinguish it from other autographs of persons similarly named. The pressing importance of unifying, at the earliest possible moment, the definition of a trade mark, was somewhat fully

*Account of Fees from 1st Jan., 1876, to 1st Dec., 1880.

	Number.		Amount. £	s	d.
Applications	11,749	...	16,607	13	4
Advertisement Fees (additional space in *Journal*)	2,229	...	621	15	0
Oppositions	287	...	606	0	0
Registrations	14,676	...	10,970	6	4
Duplicates of Notification of Registration	112	...	11	9	0
Certificates of Preliminary Procedure	15	...	3	15	0
Certificates to obtain Registration Abroad	614	...	164	13	0
Certificates for Use in Legal Proceedings	86	...	88	3	0
Certificates of Refusal	212	...	134	0	0
Registrations of subsequent Proprietors	235	...	127	9	0
Folios of Office Copies of Documents	3,039	...	25	6	6
Searches and Inspections	4,801	...	241	0	7
Rectification of Register	47	...	25	0	0
Cancelling of Entries on Register	11	...	2	15	0
Altering Address on Register	4	...	1	0	0
Fees on Settling Special Cases by Registrar	4	...	4	0	0
			£29,634	5	9

dwelt upon in a paper on the subject, which, conjointly with Mr. Israel Davis, M.A., Barrister-at-Law, I had the honour to contribute to the International Congress on Industrial Property, held at Paris during the Exhibition of 1878.*

It is not my intention here to pursue this subject further. I will simply remark that it would be well if the manufacturers and merchants of England would unceasingly exert themselves to bring about an international trade mark law. No country would be more benefited by such a law than our own.

For the purposes of the Trade Marks Registration Acts, the definition of a trade mark became necessary, and, having regard to the preconceived notion that a trade mark consists in any name or device adopted to designate goods, its definition must have been found exceedingly difficult; and it may be mentioned that practice is considered by many to have shown that the definition adopted might have been improved upon.

Certain it is that much of the litigation of the last five years about trade marks has arisen out of this definition, by reason of its restrictive character, and the distinction it creates between old and new marks—old marks being all those in use prior to 13th August, 1875 (the date of the passing of the Act), and new marks all those not used prior to that date.

Prior to the new Acts, the common law recognised as a trade mark, a signature, a figure, a fancy name, or a letter, or a combination of letters or words, or a device. Under the Acts, letters, words, figures, or combinations of letters, words, or figures are only recognised as capable of registration when in combination with a device, mark, heading, label, or ticket.

Let me give some instances bearing upon, and illustrative of, the subject.

Word Marks and Decisions relating thereto.—Soon after the Act came into operation, an application was made to register the fancy word, "Acilyton," which had not been used as a trade mark before the passing of the Act. The Master of the Rolls refused to order it to be registered, holding that only those words which had been used before the passing of the Act as trade marks could be registered; the reason assigned being that, under the definition of a trade mark given in the Act, a new word could not rightly be claimed. The practical result of this decision was to exclude from registration all fancy words invented and first used after the 13th August, 1875. So, while "Anatolia" as to liquorice; "Eureka" as to shirts; "Glenfield" as to starch, and a number of other such words, are all trade marks, it is not now competent for any person to create a new trade mark of any such fancy word. As fancy names are among the best remembered of trade marks, the result is to give to articles so named, and established in use before 1875, an important advantage, and to check the continuation of a system which, in the past, has been proved to possess great commercial value.

Another important restriction on the definition of trade marks was arrived at by the decision, on the application of Messrs. Mitchell, the well-known pen manufacturers, who had used the letters of the alphabet from A to W, as descriptive of the various qualities of the pens made by them, and which were known to the trade and the public as "Mitchell's A," "Mitchell's J," &c. Section X., after defining what, for the purposes of the Act, is regarded as a trade mark, gives the power to add thereto (that is, to such trade mark), "any letters, words, or figures, or combination of letters, words, or figures." The plural is used throughout. Messrs. Mitchell applied to register all these letter marks separately; the registrar refused, and the Court upheld the refusal, on the ground that, as the definition of a trade mark in the Act was in the plural, and spoke of letters or combination of letters, a single letter did not come within the definition, and so was not such a trade mark as could be registered under the Act. This decision has had the effect of excluding from registration all single letters and numbers, unless in combination with something else. How far this is good law may be doubtful, as another learned judge held—and on this point his decision has not been reversed by the Court of Appeal—that under the Act all marks that the Court would have protected by injunction before the passing of the Act of 1875 can be registered under the Act, the definition of a trade mark given in the Act applying to new marks only. This opinion is based on the idea that the object of the Act was to protect property, that in all marks used before 1875 the owner had a property, and that that property should be protected by the Act, which could not interfere with vested rights; that, therefore, the definition of a trade mark given by the Act only applied to new marks, the Legislature having the right to say before giving its protection to things in which no right of property already existed, that its own terms should be observed as a condition of giving that protection. Although the case in which Vice-Chancellor Malins lays down these doctrines was cited in the argument in Mitchell's case, the Court did not then accept the doctrine, but decided that for the purposes of registration, the definition in the Act applied to all marks, new or old.

In connection with numbers, I am not aware of any test cases having arisen, but that it should be possible for a paper manufacturer, whose mill number happens to be 10 or 11, to register such number as his trade mark, and that registration to the owner of mill No. 8 or No. 9 should be refused, seems anomalous. Paper manufacturers frequently consider their mill numbers as their trade marks, and many are so registered in Class 39, some separately as mere numbers, others as part of the registered labels, or ream wrappers used in the paper trade.

In Class 3 has been registered a mark consisting of the words "Trade Mark" with the letter and figure "A 1" in combination. The words "Trade Mark" cannot be claimed as special or distinctive, being only permissively placed upon the register in connection with old marks. The combination "A 1" only comprises a single letter and a single figure—a hybrid plural. This restriction as to the plural would certainly appear to need some consideration when the matter again comes before the Legislature. May it not be regarded as accidental

* "Congrès International de la Propriété Industrielle," No. 24, page 635. (Paris: Imprimérie Nationale, 1879.

in the Act of 1875? No reason can be traced, so far as I am aware, for placing owners of marks consisting of single letters, or single figures, or one letter and one figure in combination, under so special a disadvantage.

In reply to remonstrances made on behalf of an applicant for the registration of an old word mark which had been refused, the registrar some time since, with much justice, and, as it must be admitted, with very commendable frankness, wrote, that "it was only by a very gradual process that the Commissioners were able to settle the principles on which the distinctiveness of marks consisting of words only could be determined." In the early stages of the work of the office, many word marks were entered upon the register, applications for which, if tendered at a later date, would not have been entertained. For instance, in Class 3 (mostly described as medicines) there are upon the register such word trade marks as "Infant's Relief," "Family Salve," "Mother's Hope," "Bosom Friend," and many others of a like character. Vice-Chancellor Hall, in December, 1879, granted an injunction in respect of "Family Salve" as the registered trade mark of the owner, infringed by one who had been in his employ as an assistant. In June last, Vice-Chancellor Bacon ordered the registration of the words "Kitchen Crystal Soap" to be completed, considering them as "special and distinctive," it being proved in evidence that these words had been used as a trade mark for twelve years. The registrar had declined to register these words upon the application of the owner of the mark, a Philadelphia manufacturer. The same words, curiously enough, had already previously been registered, conjointly with a monogram, for a British soap manufacturer claiming a user since 1862. To the parties concerned the later practice adopted at the registry may appear as operating injuriously as against the later applicants. It is not really so, however, for it was open to all owners of old marks in use prior to 13th August, 1875, to forthwith lodge their applications on 1st January, 1876, when the registry was opened. Having neglected to do so, it is by their own default that the opportunity has been lost. Registration, conjointly with signature or device, has now to be resorted to in connection with such old marks equally as with new ones. It only remains to express the hope that, should future legislation provide for the rehabilitation of the status of word marks, all meanwhile registered under the present system may be recognised retrospectively, or their re-registration as words alone be provided for.

This class of marks has been still further limited by the decisions that have been given on the words themselves. To constitute a trade mark, it has been held that the mark must not bear any relation to the subject matter in respect of which it is applied, and this whatever period of user may have belonged to it. Thus, "Nourishing Stout" was held not to be a trade mark, because merely descriptive of the article. But a word such as "Angostura," when applied to bitters, being not descriptive but distinctive, was held to be a trade mark; the test in each case being, "Is the word distinctive or merely descriptive?" If distinctive, then however absurd or far-fetched (and the more so the better), it is a trade mark, and entitled to protection; if descriptive, it is under no circumstances to be registered. This point was dealt with in the case of Lamplough's Pyretic Saline. Mr. Lamplough claimed the use of the word "Pyretic," but the Master of the Rolls, in the first instance, and the Court of Appeal afterwards, held that there could be no property in an adjective simply descriptive of the quality of the goods sold. In another case a contest arose between the words "Valvoleum" and "Valvoline"; both fancy words, both invented to describe the particular article; but each as a trade mark used in combination with a different device; here it was held that no property existed in either word, as both were only another form of stating that the substance was valve oil.

The effect of the decisions having, therefore, been to limit materially the number of fancy words that could be registered, a further point arose on the use of names as trade marks in cases where the name had been used by various manufacturers, as applied to certain classes of goods, such as the word "Berlin" in connection with wools, "Axminster" for carpets. This point was settled in the case of the word "Alloa," as applied to yarns. An application was made to register the word "Alloa" as a trade mark, by a manufacturer who carried on business at Alloa, and manufactured a species of yarn known in the trade by the name "Alloa." The registrar refused to register this word, and his refusal was upheld on the ground that although the word "Alloa" might have been a trade mark if used to denote the goods of one manufacturer, yet, as it had come to designate not a particular maker's goods, but a special kind of goods made by different makers, it had ceased to be distinctive of the maker, had become descriptive of the material, and so could not be a trade mark.

So great a hardship has the public found the restrictive definition of a trade mark, that every conceivable device is resorted to with the view of obtaining the much-coveted right to use, and if possible to protect, fancy names as trade marks.

A vast number of word registrations have been effected in many classes, the system most frequently adopted being to combine the desired word with the signature of the applicant. In use, such words sometimes appear conjointly with the signature, then, of course, corresponding with the full description on the register; but, in many instances, the fancy word is all that it is desired to use and claim, and the signature is omitted.

The question arises, "To what extent are fancy words protected when so used alone?" Upon this point the decisions of the Court will be most anxiously awaited when the question is tried. The word is on the register; fees in respect of it have been paid; the Act has allowed it to be added to the essential portion of the trade mark, viz., the *fac-simile* signature, but has not distinctly specified whether in being so added it acquires the same protection as the signature or as any trade mark distinctive and complete in itself; whether, in fact, it is at all such a portion of the trade mark as can be protected. Against this, it must be noted that, under the Act, the signature is made the essential particular, the addition of a word or combination of words being merely permissive. The question comes to be whether the registration protects the

combination, or only the essential feature. This has to be answered in all cases.

The importance of the interests involved cannot be overrated, and of this the columns of the newspapers afford ample evidence. For instance, take one industry alone, that of the new temperance drinks. In connection with these it is of paramount importance to obtain a distinctive name, and to identify the same with the particular article to which such name has been first applied. Although some of these drinks are patented, it is only under a distinctive name that they can be identified by the public.

Does registration of the name of a particular drink, in combination either with a device or the signature of a firm, give the owner of that drink a right to restrain another who may sell a beverage under that name manufactured by himself, the beverage being distinct from that originally patented? Take, for instance, the words "Hedozone" and "Zoedone," which are not old trade marks. It is, I apprehend, sufficiently significant of the necessity which exists for further legislation on the subject of trade marks, that a doubt on a question of this nature, in which capital to the extent of, perhaps, millions of pounds sterling is involved, should exist. If the Legislature did not intend to accord protection to the letters, words, and combinations of letters which may be registered as ancillary to the essential portions of the trade marks, is not the Legislature misleading the public, and, in fact, permitting registration fees to be paid in respect of a protection which is not given? *

The statistics on this subject show the value which the public attach to the privilege of being able to acquire rights in words. Selecting seven classes in which word marks are most prevalent, I find that out of a total of 5,573 marks applied for in such classes, as large a proportion as 1,336 consist of word marks.† If in the particular industries comprised in these classes word marks have in the past proved the most suitable, why should the Registration Act incidentally hamper such trades in the future by restricting them in the use of such marks? The introducer of a new brand of iron, &c. is at a disadvantage since August 13th, 1875, as compared with what was open to him at any preceding time.

Words are registered, in combination either with signatures or devices, in many classes. Of such registrations there are but very few indeed in which any value is attached by the owners to the device, or the *fac-simile* signature, registered in combination with the word. The registration of the signature or the device becomes, in almost every instance, a mere subterfuge, and various manœuvres are resorted to for obtaining this much desired, but very questionable, privilege of placing fancy words on the register.

The penalties upon imitating signatures are so serious, that in but rare instances are imitators bold enough to indulge in the luxury of forgery.

In the course of my investigations, I have come across a number of amusing instances, in which manufacturers have resorted to proceedings which have the appearance of constituting violations of the Act, with a view to secure an exclusive right to the use of a series of words and fancy names, by varying their signature with each. A signature in any particular form is only accepted at the registry once, but may again become eligible by varying it, changing the form of any of the capital letters, or adding or omitting a flourish beneath the signature.

In this manner a firm consisting of three partners—Brown, Jones, and Robinson—exercise the right of registering one fancy word in combination with the ordinary trading *fac-simile* partnership signature of each partner, thus effecting three word registrations. Beyond this, each partner, by merely varying his signature, can register another word, the firm acquiring three additional registrations. Again varying the signature in each instance, by introducing printing letters to the capitals of the names or otherwise, a third combination is created, and three more fancy words placed upon the register. The firm in this way can obtain nine such registrations, and provided that their ingenuity be equal to their future necessities, why should they not be able to continue doing so almost *ad infinitum?*

In another instance, an individual trading, as is so very usual in business, with the addition "& Co." registers in the first instance a fancy word in combination with his ordinary *fac-simile* signature, "John Robinson." Introducing a second fancy term in his business, he registers this in the same class as the first, in combination with the *fac-simile* signature, "John Robinson & Co.;" in a third instance he utilises the signature, "J. Robinson;" and, in a fourth, "J. Robinson & Co." For a fifth he will doubtless take "John Robinson & Company;" for a sixth he will still have at his disposal "John Robinson & Compy.;" and even in case of necessity, "J. Robinson & Compy." for a seventh; backed up, with further variations, by "and" in full. An individual with only one Christian name is, in these instances, at a great disadvantage, as compared with those possessed of a series, every additional Christian name permitting the double combinations of utilising the same in full, and, under its initial, for an additional pair of registrations.

It is of the utmost importance that the exact status of this class of marks, forming so important a proportion of the new marks placed upon the register within the five years under discussion, should be established. If the registrations are good, no doubt should attach to them. If they are bad, the register should be purged of them, and no more be added.

A friend of no mean authority on the subject of trade marks remarked the other day that, for

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* The following questions have been suggested by a member of the bar who has given much attention to this subject:—"Is the drink patented or not?" "If not, why may not every one make it; and if one makes it, by what name is he to call it unless by that which is the true and known one?" "If he invents a new name he describes the article as different from the old one, and misleads the public?"

† Class.	Total Marks Advertised.	Word Marks.
3	1,065	175
5	1,409	515
6	502	192
18	226	92
38	572	126
44	540	57
49	1,259	179
	5,573	1,336

some purposes of commerce, he considered a trade mark consisting of a fancy name of far greater value than any device. Without altogether agreeing with my friend's opinion, I am certain that a large proportion of those interested in trade marks take his view, although many urge that the best plan is to register a device, *e.g.*, an animal, as a tiger, and to get the article known to the public as "tiger" ale, &c.

Registration is a boon for which the manufacturers of this country had continuously asked for upwards of twenty years. Lord Cairns, as the author of the Registration Act, undoubtedly intended that it should prove of the utmost use, not that whilst giving with one hand what was sought, with the other new restrictions on commerce should be created.

I have certainly never heard of any reasons which appeared to me to be valid or of weight, why a novel and fancy word should not be allowed to constitute a trade mark. No confusion can prevail. Any one desirous of using a name in connection with a particular class of goods, can always ascertain whether such name is already on the register.

Cotton Marks and Decisions relating thereto.—From the beginning, it was foreseen that very special difficulties would be found to prevail in the preliminary investigation of the claims for registration of cotton marks.

The Commissioners of Patents deemed it advisable that a duty of so technical a nature should to a great extent be carried out by gentlemen themselves interested in the trade, and likewise able to bring to bear local and general experience. In this view, a committee of experts acquainted with the usages of the cotton trade was, with the co-operation of the Chamber of Commerce at Manchester, nominated by the Commissioners of Patents.*

To this committee was entrusted the duty of reporting to the Commissioners upon the marks claimed as in use as private property, and so within the meaning of the Act entitled to registration, as distinguished from what were to be deemed as open marks outside the scope of the Act. The investigation involved was of a most tedious character, and necessitated the deferring of the coming into full operation of the Act of 1875, extended for one year under the Amendment Act of 1876, and subsequently from time to time further prolonged, by successive Orders in Council to 31st July, 1879.†

The Manchester committee commenced its labours in October, 1876, having its office at 48, Royal-exchange, Manchester, of which Mr. Joseph Fry was appointed keeper. The committee, in the first instance, proceeded with the examination of the 41,712 marks applied for in Class 24, "Cotton Piece Goods." One of their early decisions in regard to combination marks being questioned, the examination of the old marks could not be completed within the prescribed date, and this, in a measure, necessitated the extension of time referred to above.

At June 30th, 1877, the committee had examined 33,681 marks, leaving 8,031 to be dealt with later.

The number to be examined in the first instance would have been considerably greater but for the United Bleachers' Asssociation having, at an early stage, consented to the withdrawal of the whole of their marks, to the number of upwards of 16,000. These were placed in the category of open marks, thus saving much labour and possibly litigation.

The committee in all held 145 meetings prior to completing the investigation of the old marks.

The total number of marks considered was 44,158, composed thus:—Class 23 (cotton yarn and sewing cotton), 2,490; Class 24 (cotton piece goods), 41,455; Class 25 (other cotton goods), 213.

Of this extraordinary number the remarkably small proportion in the respective three classes passed as capable of registration under the Act was 938, 3,413, and 187, respectively; in all, 4,538 out of 44,158—just over 10 per cent.

Meanwhile the Lord Chancellor had divided Class 23 into two divisions, thus providing for a difficulty which had presented itself in regard to cotton yarn and sewing cotton in consequence of the original classification not having divided cotton yarns from sewing cottons.

Similarly, under a special rule, dated February 20th, 1877, it was provided that cotton marks need not be advertised with illustrations in the *Official Journal*, but that the marks should be on view simultaneously at the registry in London and at the Manchester office for a period of three weeks after they had been advertised in the *Official Journal*, under their mere official numbers, with particulars of ownership and date of user. This period was by some deemed to be very short for opposition to be made, particularly as compared with the minimum interval of three months provided in connection with marks advertised with representations. No difficulty or injustice has, however, been traced to have arisen under this head, no doubt from the fact that the utmost vigilance was exercised by the Manchester committee in the first instance in approving the applications for the marks, which the registry subsequently proceeded to advertise.

The first marks in Class 23 passed into the stage of advertising were announced in *Journal* No. 107 (September 5, 1877); the first in Class 24 in *Journal* No. 152 (November 27, 1878); and the first in Class 25 in *Journal* No. 113 (October 17, 1877).

Registration followed in most instances soon after the expiry of the three weeks' interval, the references to the original representations at the registry and the Manchester office meanwhile made being comparatively few.

The Manchester committee of experts, having divided all the cotton marks into two great classes—the "A" list comprising those in which a distinct private right existed, and the "B" list those that, having been used by more than three persons, had lost their distinctive character and become common or open marks—many complaints arose on the part of persons who were placed on the "B" list, and who alleged that their marks were not public, but private property.

The dispute became complicated by questions as to what was the exact position occupied by the Manchester committee. It was contended by some

* *Manchester Cotton Committee.*—Edmund Ashworth, Esq., President of the Chamber of Commerce, Manchester; A. Bernus, Esq., Charles S. Carlisle, Esq., James Chapman, Esq., W. F. Danson, Esq., B. Davies, Esq., George R. Davies, Esq., S. A. Fulda, Esq., P. Goldschmidt, Esq., C. P. Henderson, jun., Esq., A. J. Hunter, Esq., H. J. Leppoc, Esq., G. Lord, Esq., J. W. D. Mather, Esq., E. Crompton Potter, Esq., E. Reiss, Esq., S. P. Schillizzi, Esq., H. M. Steinthal, Esq., E. H. Sykes, Esq., A. Wallace, Esq.

† Orders in Council, December 12, 1877; June 29, 1878; November 27, 1878; and May 17, 1879.

applicants that they were only a number of persons who, having a special knowledge of the trade and its marks, were deputed to arrange and classify such marks. Others claimed that in effect the committee was a judicial tribunal—a tribunal of commerce—and that its finding on matters of fact could not be questioned or interfered with, unless it was shown that the committee had acted illegally or wrongfully. Vice-Chancellor Hall adopted the first view, and held that he was at liberty to disregard the decision of the committee, to look at the evidence for himself, and to draw his own conclusions. The Court of Appeal took a different view, holding that the decision of the committee was *primâ facie* conclusive. The House of Lords, on appeal, reversed the decision of the Court of Appeal, and affirmed the judgment of the Vice-Chancellor, thus holding that no judicial character whatever belonged to the committee. Lord Blackburn's judgment fully summarises the position.*

The Courts being at liberty to go behind the decision of the committee of experts, several cases have since arisen in which their decisions have been questioned, and questioned successfully.† Each of the cases, to a great extent, involves questions not of law, but of fact, and depends on the facts peculiar to it. The practical result of the cases is that the decision of the committee is only taken as shifting the onus of proof, and throwing on the person who applies for the order to register the onus of proving his title to the mark.

Interesting and important questions have arisen, questions which cannot be said to be in any way settled. In a recent case, a mark had been placed on the "B" list that had been used for upwards of fifty years by the particular firm who claimed it, and to their knowledge had been used by no one else. But it appeared that various bleachers to whom the manufacturers brought their goods to be bleached were accustomed to ask their customers what kind of finish they would like placed on their goods; did they want "X's" finish, or Y's," or "Z's"? These bleachers kept books containing all the marks of the chief manufacturers, any which they would put, if asked, on goods brought them to be bleached. Could this fraudulent use by the bleacher deprive the manufacturer of his property in the mark, so as to make the mark an open one? It would seem that it could. For the manufacturer, it is said, ought to have known, and would be taken to have known, that these marks were being so used. Again, would it make any difference if the mark had been affixed by the bleacher for export only, and had never been used in this kingdom, but only abroad? This point seems still to be undecided. It appears to be more a question of fact than of law, whether the manufacturers had the means of knowing, and could they be reasonably said to have known, if they had used due care and vigilance? If so, their right would be gone. In some cases the matter was still further complicated by the fact that the bleachers were all united together as members of an association, and that the association included the bleachers who bleached for each manufacturer. Did this fact of the bleacher being in effect the servant of the manufacturer, and being a member of, and knowing what was done by, the association, affect the master, the manufacturer, with notice, so as to impute acquiescence to him? It would seem to have been held that the manufacturer lost his rights. This extension of the doctrine of implied notice to trade marks, which has had the effect of depriving the owner of valuable marks of his property, and giving the right to use them to the world, seems unjust. The result of its application has been yet worse; for owners of marks whose titles, if the Act had not been passed, would have been undisputed both here and abroad, have found themselves deprived of valuable property, because they have not hunted up and prosecuted all possible cases of infringement. Had not the Act been passed they would probably in all cases have been able to obtain injunctions to protect their property. Now, with the decision of the Manchester committee against them, and that decision supported by the public purse, with the aid of the law officers of the Crown, their chance is small. What is still worse, the Manchester committee allowed any person to send in any marks he pleased; they took no evidence; they required no proof; they acted on the representations sent to them; so that infringers, by merely sending in their infringements, not only deprived the owners of their exclusive rights to their marks, but also succeeded in obtaining a legal right to infringe for the future; for if the mark once became common property, the owner's right was gone for ever. Nor did the abuse stop here; in a recent case a bleacher had the assurance to apply to be allowed to register a manufacturer's mark, and was allowed to do so. Thus, by means of an Act passed for the protection of property and the prevention of fraud, the pirate is not only enabled to escape from being punished for his piracy, but to acquire an exclusive right in the property he has pirated.

This is not the worst aspect. The startling sight is occasionally seen of the Attorney-General, at the cost of the public, acting as the champion of the pirate. The Commissioners of Patents, in most cases, say they are bound to uphold the decision of the Manchester committee, and, for this purpose, to oppose any application the manufacturer may make to have his property restored to him by applying to the Court to enforce the registration

* "It would not be usual, or according to the usual principles of justice, that these persons (the committee) should determine upon a question of property without a hearing. The fact, therefore, that the proceedings of this committee are by rules entirely *ex parte*, in my own opinion, goes very far indeed to show that the opinions of the committee were not meant to be final, even to the limited extent the Court of Appeal thought them binding. But I think it rests with the registrar of trade marks to show that these rules are so framed as to make the decision binding, and I find no words to express that the appeal, especially reserved to the Court by the 62nd rule, shall be clogged by anything more then that weight which common sense requires should be given to the opinion of such a body. If the appellants took proceedings to prevent any one from infringing their firm's trade mark, they would have to make such a case as in the opinion of the Court would outweigh the opinion of the committee. I cannot but think that if they make such a case now, they are entitled to an order."

† One of these cases was Hoyle and Sons, Limited, where the British and American flags, with the words "Union is Strength," were ordered to be registered. Another was Dickinson, Ackroyd & Co.: a Chinese figure holding a scroll bearing Chinese characters was regarded by the committee as an ordinary mandarin, although claimed as "Ka Kum," a Chinese philosopher. Vice-Chancellor Hall ordered registration. The same judge ordered registration in Dugdale's case of a phœnix and demi-griffon, and in Siltzer's case of a jockey riding, both of which had been placed by the committee in Class "B."

of his mark, notwithstanding he is placed on the "B" list. If this application was allowed on a *prima facie* case being made out, the applicant would be brought face to face with his opponent, who could oppose the registration, and the case would be tried on its merits; but this is not done. The registrar opposes the application to proceed with the registration. Evidence is collected at the public expense, counsel are retained by the registrar at the public expense on behalf of the pirates, and the edifying spectacle is seen of State-protected fraud contending with the honest trader. Moreover, the money used by the registrar in the litigation is the money paid by the fair trader to register his mark; and this money is spent in fighting the battle of the unfair trader. Surely this is carrying the *sic vos non vobis* doctrine to its utmost limit.

An important question arises out of these disputes. Does the old maxim, *Quod ab initio vitiosum est nullo modo convalescere potest*, apply to trade marks? Does fraud give any rights? Strangely enough it would seem that here fraud, if it does not give rights to the wrong-doer, so as to enable him to be entered on the register as the owner of a pirated mark (a point upon which, so far, there is no decision), yet gives the pirate the right to keep the owner off the register. This has been the practice, but it seems hard to believe it to be good law.

Before leaving the legal side of the subject, there is one point to which attention should be directed, as it is one of considerable practical hardship, the important question of costs. It has been decided that the Court has no power to order either the costs of the preliminary proceedings between any two parties before the registrar, previous to the case being set down for hearing, to be paid by the unsuccessful litigant, or to order the registrar to pay costs if it turn out that his opposition is either wrong in law or vexatious in fact, the reason being the peculiar wording of the Act and rules on the subject of costs. As to private litigants; it is only right that all the costs the successful party is put to should be paid by the unsuccessful, as in ordinary cases, for otherwise an encouragement is given to frivolous litigants proceeding up to the point where no risk of costs is incurred. As to the registrar; it is only fair that, as the Crown now both gives and receives costs, this rule should be extended to trade mark litigation, especially when it is borne in mind that it is out of the fees paid by applicants for registration that the registrar is enabled to find the fund for litigation.*

Needle Labels.—With needle labels difficulties similar to those found in respect of the old cotton marks prevailed.

A certain number of gentlemen in the trade were accordingly invited by the Commissioners of Patents to constitute themselves a Redditch Needle Committee.†

The marks submitted for consideration attained a total of 2,425, of which, upon investigation, only 677 were passed as private marks, the remaining 1,748 being regarded as "open" or "common" marks.

Sheffield Marks.—The Cutlers' Company of Sheffield, under Section IX. of the Act, and under Rules 46 to 56, have their rights reserved, as was provided under the Merchandise Marks Act, 1862. The registry was to be provided in due course with copies of all Sheffield corporate marks, and the Cutlers' Company, on the other hand, to receive from the registrar copies of all marks tendered in respect of manufactures corresponding with those included in Section II. of the Cutlers' Company's Act, 1860. No new corporate mark can be granted at Sheffield, nor any cutlery mark registered here without mutual concurrence of the registrar and the company. Comparatively but a small amount of litigation has arisen in connection with this class of marks. Registration on the part of Sheffield owners being optional, a number remain unregistered in London.

Colour.—The Act defines in precise terms what is to be deemed a trade mark. It is silent as to colour, design, outline, or form. Whilst open to use in all colours, and registered in black and white only, the representations lodged with the application can present the particular colour or combination of colours used in trade, thus permanently recording them. In some instances the identity of a mark always used and known under some particular colour (such as Bass' red triangle) is entirely lost when presented in black and white, as printed in the *Journal*. Notwithstanding this, it may justly be urged that the owner is actually better protected by registration without reference to colour. Registered in no colour, he is in fact registered in all colours, whereas if registered in one and only so protected, other colours might be claimed by future applicants. Cotton marks are, in fact, registered in colours as used, the registration being by deposit, and colour in their case becoming an element in infringement.*

Similarity of Marks.—Some learned judges seem to consider that, in the case of a contest between two persons as to similarity of trade marks, the Court is bound to regard questions of colour and size, though the registrar disregards these points, as colour is not protected by the Act, and there are no restrictions as to the size of marks. It is said, on the one hand, the Act contains nothing about form or outline; the mischief to be guarded against is the mischief to be done to one person by another in the course of trade, and in the use of these marks in trade. It would narrow the construction of the Act to say that the Court is only to look at the mark as printed in the advertisements, not to look at the mark as it will be used in the course of trade. Against this it is said, if the mark is fairly printed—printed as advertised—it will not deceive. If, however, it is used otherwise, printed in such a way as not to bring out its distinctive features, that would not be a fair printing; that use would not be a fair use. It would not be the use of the design registered, but the use of something else, not the distinctive mark proposed to be registered. In considering the point

* In *re* Rotherham the applicant was put to the costs of a trial and of an appeal, although he succeeded in both instances.

† *Redditch Needle Committee.*—J. F. Milward, Esq. (Chairman), William Avery, Esq., W. H. English, Esq., Thomas H. Harper, Esq., C. B. James, Esq., Walter Lewis, Esq., Joseph Mogg, Esq., John Rogers, Esq., Henry Thomas, Esq., G. F. Townsend, Esq., R. B. Turner, Esq.

* Judgment of the Master of the Rolls in *re* Robinson 29, W. R. 31.

if registration should be allowed, the Court should not consider whether, by a dishonest use or dishonest printing, the mark could be made such as to deceive, but whether, assuming it was printed and used with the distinctive design still kept up, it is calculated to deceive from its similarity to another mark already registered.

If this latter view, which is that of Lord Justice Cotton, is the true exposition of the law, a very large number of marks that have been refused registration would still be entitled to claim it. But it opens a door to fraud, which would be certainly used by the dishonest trader; and, as the law now stands, facilities for dishonesty are already too plentiful.

The registration of a triangle containing the representation of a church was successfully opposed, it being held that whilst distinct when presented in black and white, the triangle containing the church could in subsequent use be coloured red, and the church thus be so much obscured as to render the mark similar to that of Messrs. Bass. The expression "calculated to deceive," should, it was laid down, always be interpreted in its broadest signification, so as to discourage the evil of imitation and to facilitate remedy.

Another class of cases arose, where two or more persons, in ignorance of the use by each other, had both used the same trade mark for goods in the same class. Could each be registered, or did the use by two persons deprive the mark of its distinctive character, so as to make it incapable of registration? On the one hand, it was urged that as each had used the mark independently of the other, each had acquired a property in it. On the other hand, it was argued that the use by more than one person had deprived the mark of its essential character of distinctiveness, and so it had ceased to be a trade mark. A compromise resulted, the Commissioners of Patents deciding that in respect of the same mark in the same class, three persons might be registered.* If more than three were proved to have used it, then no one could be registered, as the mark had lost its character of distinctiveness, and ceased to be a trade mark. The applications of this ruling have already been numerous, and if it be possible to take advantage of it to the full extent in the fifty classes, there is the chance of some favourite old mark appearing on the register one hundred and fifty times.

As a result of the comprehensive list of manufactures included in some of the classes, it frequently happens that two or three persons desire the use of the same mark in connection with goods wholly dissimilar, but included in the same class. In such cases I think it might well be left to the registrar, with the mutual concurrence of the persons desiring to use the same mark, to permit them to be entered upon the register, each restricted to his own special manufactures. The following could not, I think, ever come into collision — Patent fuel with beer and wine finings; knapsacks with wooden tops for bottles; hair plaits with straws for sherry cobblers; dog whistles with incubating machines; blind cord with sea water for bathing; snuff boxes with artificial flowers; mouse traps and rolling pins with bridges and summer houses; tarpaulin with dram flasks, and so on. All these, with a multitude of others, are comprised under "Miscellaneous" in Class 50.

The registration in the adjoining class (Class 49) of any mark in respect of billiard tables would preclude the use of a similar mark for fishing nets. These, again, could never come into collision. Is it desirable to extend to other classes the system of subdivision as adopted in Class 23?

Antiquity of Marks.—Of the marks early advertised, the largest number of those for which very old user is claimed, are from Sheffield, and those are registered, in most instances, in Classes 5, 6, 12, and 13. One of these marks dates back nearly two hundred years; a large proportion upwards of one hundred years.* Of the marks applied for soon after the opening of the register, one, that of Köpke's port wines, dates as far back as 1638. Six others trace their origin to a date between one hundred and fifty and two hundred years ago; whilst more than thirty marks show a user of upwards of one hundred years. Amongst the oldest marks are several registered in the name of the King of Saxony (Class 16), dating from the year 1733. The words "The Coffee Mill," registered in several classes by Messrs. Berry Brothers, of London, have a user of one hundred and fifty-five years before December, 1875. The name "Wedgwood" has been a trade mark since 1776. Some of Messrs. Offley's port brands are older still. Croft's date from 1776. Messrs. N. Johnston and Sons and Messrs. Hunt, Roope, and Co. claim upwards of one hundred years user for their wine marks; Messrs. Taylor, Fladgate, and Yeatman upwards of one hundred and fifty years for theirs. Gautier's brandy mark has a user of one hundred and twenty years; Ruinart's champagne, one of a hundred and fifty years. The words "Singleton's Golden Ointment" stand registered in Class 3 with a user of over one hundred and two years before 1876. The groceries of Messrs. Farquharson, of Aberdeen, carry a label bearing the date 1694, although under its registration it is only modestly claimed as having upwards of one hundred years' user. One of the Chocolat-"Lombart" labels dates its user at Paris since 1760. The Kendal tweeds of Messrs. Wilson

* This has been laid down by the Master of the Rolls in his own Court and recognised by Vice-Chancellor Hall. Would the Court of Appeal and House of Lords recognise it as warranted under the Act?

	First used in
* George Wostenholm and Son, Limited, Washington Works, Sheffield	1694
John Nowill and Sons, Nowill's Cutlery Works, Sheffield	1700
John Kenyon and Co., Sheffield	1716
William Hall, Sheffield	1718
Edgar Allen and Co., Well Meadows Steel Works, Sheffield	1733
T. R. Cadman, 211, St. Mary's-road, Sheffield	1748
J. R. Spencer and Son, Albion Steel Works, Sheffield	1749
John Pitchford, Sheffield	1760
Isaac Greaves, Sheffield	1762
Joseph Rodgers and Sons, Limited, 6, Norfolk-street, Sheffield	1764
John Wilson, Sycamore-street, Sheffield	1765
Rawson Bros., 21, Carver-street, Sheffield	1772
Joseph Wostenholm and Sons, Perseverance Works, Penistone-road, Sheffield	1773
Gregory and Bramall, Soho Steel Works, Sheffield	1773
William Wilkinson and Sons, Grimesthorpe, Sheffield	1776
Peter Stubbs, Rotherham and Warrington	1776
S. and R. Linley, Clough Works, Sheffield	1776
Saynor, Cooke, and Ridal, Paxton Works, Edward-street, Sheffield	1777

have a trade mark dating from 1776. Messrs. Weston and Westall's salt mark, the "Horse," is upwards of one hundred years old. Many of the iron marks have a user of upwards of one hundred years.

It may be observed that marks which claim the greatest antiquity are not always those the most widely known. Messrs. Bass' beer label, with the triangle, which was tendered for registration on the opening day, and will go down to posterity as No. 1 on the English register, had a user of only twenty years claimed for it on January 1, 1876. Farina's eau de cologne marks, the first on the German Register at Cologne, and presented quite early for registration in this country, date less than fifty years back, though the house has been established since the beginning of the last century.

Exhibition Medals.—Medals are registered as parts of old trade marks, if used as such before August 13th, 1875. A difference is thus created which is scarcely fair to manufacturers who previously to that date had gained such distinctions, but had not made the same use of them. Medals, it has been decided, are not in themselves trade marks. Their wrongful use, however, is made penal under the Exhibition Medals Act, 1863, so far as concerns the Exhibitions of 1851 and 1862, but so far only. This subject was fully dealt with in a paper contributed by Mr. Willis-Bund to the Paris Congress of 1878, already referred to.* The position of medals, when grouped so as in themselves to wholly constitute a trade mark, or when used as parts of trade marks introduced since the passing of the Registration Act in 1875, cannot be regarded as otherwise than most unsatisfactory. It is contemplated to urge upon the Government next Session to introduce a Medals Amendment Bill to cover all exhibitions—national and international—conducted under Royal or other Commissions, or with the recognition of the Board of Trade. Viewed as trade marks, or parts of the same, representations of exhibition medals have to be regarded as common to a large class of persons, although not to everybody. A medal can never be the trade mark of any individual.

Trade Marks Exhibition.—For use in the room this evening, I have, at the request of the Council, had brought here the volumes constituting what is known as the "Trade Marks Exhibition." In this collection, each of the fifty classes in which trade marks are registered has its separate volume or volumes, and index. Reference for each particular trade is thus facilitated. There are three general indexes to the whole—town, provincial, and foreign and colonial. This exhibition was opened in July, 1877, at the date when certain provisions of the Act came into operation. The convenient and complete form of reference which the volumes present has been found of much service in many leading cases. In some instances, litigation has been avoided after reference by those concerned. Concurrently with the opening of the exhibition, was commenced the publication of *Trade Marks*, a journal, of which twenty-six numbers were issued. In many respects this journal is a near approach to the *Annales de la Propriété Industrielle Artistique et Littéraire*, edited by Pataille, of Paris, which has done so much service as an exponent of the French law on patents, copyright, and trade marks. In *Trade Marks* the endeavour has been so to deal with the subject as to record as fully as possible, and to comment upon all matters of law and fact, interesting to the owners of trade marks in this country.

The subject of trade marks is by no means new to this Society. It was last brought prominently under notice in a paper read by the present secretary, Mr. H. Trueman Wood, in November, 1875.* In 1859, Professor Leone Levi read a paper† on the subject before the Society, and drafted a Bill to be submitted to Parliament. The late Mr. Arthur Ryland, of Birmingham, about the same time read a paper before the Social Science Association. At this period Sheffield was complaining loudly of the systematic forgery of its trade marks in Germany. Early in 1860, Mr. Bass moved in the matter, and under his instructions Mr. J. Travers Smith submitted a draft Bill to Mr. Milner Gibson, then President of the Board of Trade. In 1861, the late Lord Campbell introduced a Bill in the House of Lords. Mr. Milner Gibson and the Attorney-General, in 1862, introduced the Merchandise Marks Act, and at the same time a Trade Marks Bill was brought in by the late Mr. Roebuck and Mr. Hadfield, the members for Sheffield. The two Bills were referred to a select committee, receiving very full consideration. Mr. Hindmarch, Q.C., and the Attorney-General were adverse to registration, which was provided for under Mr. Roebuck's Bill, but not included in the Government Bill, and recommended that at that stage of legislation it should not be inaugurated. The Merchandise Marks Act, 1862, in the result, was passed, and came into operation in January, 1864. That Act has proved most useful, by its deterrent effect, although the number of cases in which it has been put into operation have been but few. In July, 1863, followed the Exhibition Medals Act, the result of the efforts of a committee constituted here one month previously on my representation to the Council of the importance of taking prompt action. This measure was passed through both Houses of Parliament in seven days. A Trade Marks Registration Bill was again brought in by Mr. Bass in 1866. Another Bill for the same purpose was introduced in the House of Commons in 1868. In 1869, followed the Bill of Mr. John Bright and Mr. Shaw-Lefevre. Mr. Chichester Fortescue (Lord Carlingford), conjointly with Mr. Arthur Peel, made another attempt at passing a Bill in 1873, but equally without success. It was left for Lord Cairns, in 1875, to carry through a measure to effect what had been so frequently before attempted, without result. Registration had always been urged upon the Government by the Associated Chambers of Commerce and other public bodies, but there prevailed a divergence of opinion as to whether legislation on the subject should in the first instance provide for a compulsory or a voluntary system. Many

* "Congrès International de la Propriété Industrielle," No. 24, page 647. Paris: Imprimerie Nationale, 1879.

* The Registration of Trade Marks." By H. Trueman Wood, B.A. November 24, 1875. *Journal*, November 26, 1875, vol. xxiv., p. 17.

† "On Trade Marks." By Prof. Leone Levi. March 16, 1859. *Journal*, March 18, 1859, vol. vii., p. 262.

influential deputations waited on the successive Presidents of the Board of Trade concerned in the proposed Bills referred to, and on some occasions I remember their being accompanied by Members of the Council and of the Trade Marks Committee of this Society. One such committee on a large scale was formed early in 1866, and on that occasion I had the honour to act as reporter. Soon afterwards Mr. Underdown read a paper* in this room on the "Piracy of Trade Marks." This was followed by another by Mr. Wybrow Robertson, in 1869.†

In his paper, in 1875, Mr. Wood threw out very valuable suggestions as to the mode in which the then recently passed Act might, with most benefit, be carried out. A Society of Arts Committee was formed, and held several meetings, ultimately submitting certain suggestions as to rules and regulations to the Lord Chancellor. In many respects the rules accord with the suggestions then made, notably as regards the statutory declaration and the mode in which applications are prepared, the subsequent advertising and the interval prior to registration.

The five years that have meanwhile elapsed may be considered as having afforded an ample test of the working of the Act. The rules, as at first settled, have in almost all respects remained unaltered, various additional rules being made from time to time, as circumstances required. The experience gained has left but few points to be dealt with. The present time is opportune for reviewing the result of the working of the Act. The expiry of the fifth year is the date at which the marks first applied for under the third section of the Act, commenced to acquire indisputable title as the exclusive property of the owners. In regard to this, it may be mentioned that the registrar, in July last, wisely called the attention of the Manchester Chamber of Commerce, and other public bodies, to the necessity of their causing an examination to be made of the trade marks registered during the five years then shortly to expire, with a view to taking the necessary steps for preventing any such marks which were of a general nature passing into the hands of individuals whose registrations ought to be previously cancelled. This notification from the registrar, so far as I have been able to learn, did not lead to the combined action which might have been expected. As, however, but comparatively a very limited number of marks have even now passed into the indisputable stage, there is time yet for carefully reviewing the bulk of what are on the register. In the absence of any public functionary to undertake the duty of such revision, I shall myself be willing to co-operate with any associated bodies of traders or individuals interested in taking action in this direction.

Within the limits of this paper it is impossible to deal exhaustively with any of the subjects to which it refers. I have endeavoured briefly to glance at the most important points in the commercial aspect, equally as with those of a legal nature. For what I have said in connection with the latter, I am indebted in a great measure to Mr. Willis-Bund, Mr. Israel Davis, Mr. Sebastian, and Mr. Howard Paddison, who have been concerned in many of the cases to which reference is made. For statistical information, subsequent to what has been already published in the reports of the Commissioners of Patents, I am indebted to the courtesy of the registrar.

The day, I trust, may not be far distant when a Supplemental Trade Mark Act may be passed, with the view of varying the definition of a trade mark in such a manner as to embrace an original fancy name among the essential particulars, and to admit of a letter or figure being registered as an old mark, and added to any one or more of the essential particulars of any new mark. Power, under such an Act, might be reserved for the registrar to cancel, after a specified period, all applications not completed owing to the non-payment of registration fees.

The mercantile community would gladly avail themselves of the permission to record trade labels, under a special system of registration, similar to that adopted in America. In any new Act I should like to see such a system provided for.

The rules might, I think, be advantageously varied, by giving the registrar power to amend the register, in respect of trivial alterations in registered marks, without application to the Court; and where collision is impossible, to permit two mutually consenting persons to be interested in the same mark in respect of goods of a totally different kind, although comprised in the same class.

My own feeling is that these Acts have inaugurated a new era in the history of British commerce. For the outlay of an almost nominal sum, the smallest as well as the largest manufacturer in the kingdom, by the registration of a trade mark, can secure to himself, his successor and assigns, the absolute and exclusive right to use that mark in connection with his goods, and to identify any particular class of them sold with that mark as being of an unvarying and standard degree of excellence. The public, on the other hand, learn to look upon the manufacturer's trade mark as a guarantee of such standard degree from which they know he cannot depart, except under penalty of losing both credit and custom. Thus, the trade mark affords security to the purchaser; and makes honesty the best policy on the part of the manufacturer.

DISCUSSION.

The Chairman said there were probably gentlemen present who had had experience of trade marks as used in this country, and as used by our foreign competitors, and if so, he should be glad to hear their views. They knew that England for many years enjoyed an almost unique reputation with reference to certain manufactures, such as cotton and steel goods, and many of the marks of English manufacturers had consequently acquired great value in foreign markets. But, in some foreign countries, where the English trade mark was not recognised as a property, the native competitor had coolly appropriated it, and, thereupon, he acquired, in the native market, a right to use the English trade mark, whilst the original owner of the mark in England had no protection at all. He (the Chairman) knew of a case where an English manufacturer had gone to France and asked to be allowed to register his own old mark, but the application was re-

* On the Piracy of Trade Marks." By E. M. Underdown. April 11, 1866. *Journal*, April 13, 1866, vol. xiv., p. 370.

† On Trade Marks." By W. Wybrow Robertson. April 21, 1869. *Journal*, April 23, 1869, vol. xvii., p. 14.

fused, because the same mark had been used in France by a Frenchman. If the French maker were to make an application in this country to register the mark for the same class of goods, it would be sufficient for him to say it was an old mark used prior to 1875, without stating where it had been so used, and it was doubtful if the Englishman could successfully oppose the application, because three persons, but not more, were allowed to register the same mark, if an old one. The question would probably arise some day, to what extent did the use by a foreigner in his own country, entitle him to make a declaration that he had used a mark for a certain number of years, so as to obtain registration in England.

Mr. Salaman (solicitor to the Trade Marks Protection Society) said he had had considerable experienee in this subject, which was a very complicated one, and difficult to speak upon off-hand. Mr. Johnson had treated it in a very able manner. He might say a word or two, however, on the question of the foreign registration of English marks. Recently, laws had been passed for the protection of trade marks in Switzerland, Holland, and Denmark, but, in the case of the two latter countries, there were provisions which caused great hardship to English manufacturers. There were some very old marks called cutlers' marks—Sheffield corporate marks—consisting of letters, which had, of course, been registered in England as old marks, but in Holland and Denmark the law did not provide for the registration of letters. The society he represented had made representations to the authorities of those countries through the Foreign-office, but up to the present time they had refused to register these marks. In Switzerland the authorities had seen the justice of registering all marks which had received the protection of the law in England. He considered that when these laws were about to be passed in foreign countries, there should have been at least some attempt to co-operate with England and other countries, so that these anomalies should not occur. With regard to certificates of refusal, though they placed the owner of the mark in England in the same position as he was before with regard to prosecuting infringers, in foreign countries they had no such effect. If the Courts in England gave protection to the owner of a trade mark, that ought to be sufficient to entitle him to protection in a foreign country, and the foreigner ought not to be able to infringe the mark with impunity, as he did at present. He should be very glad to co-operate with Mr. Johnson or with any body of gentlemen interested in the subject, for the purpose of obtaining an amendment of the Act, although he must say it had on the whole worked well. Why three persons should be allowed to register the same mark, and not four, he did not understand, but it had been so decided. The question of costs also was another important matter which ought to be reconsidered.

Mr. Willis-Bund thought there were one or two points which might he usefully discussed in view of obtaining further legislation. There was first the point about foreign manufactures, which was complicated by those cases in which British subjects have gone abroad and registered fraudulent imitations of English marks, and the question might arise whether such persons would be able to come afterwards and register those fraudulent marks in England. The main point to which he wished to direct attention was the definition of a trade mark, and the necessity of endeavours to obtain some new and comprehensive definition. This could not be done off-hand, and when it was done they ought to have the co-operation of foreign countries in the matter. If they were to have an international law of trade marks, they must first of all decide what was a trade mark. It seemed to him that the Act of 1875 had rather increased the difficulties, because now there were no less than four distinct classes of trade mark. Old trade marks registered under the Act, and old marks not registered, each of which had different rights attaching to them, and which would be treated differently in English Courts and abroad. Then there were new marks registered, and new marks not registered, and here, again, there were different rights existing. They wanted some comprehensive definition which would include all these. There was another important question which Mr. Johnson had briefly alluded to, viz., the case of special words which described a patent article. He had in his mind the case of linoleum. As he understood the law, it was this:—If a man took out a patent for an article and called it by a fancy name, at the expiration of the patent anybody could make the article and call it by that name, whereas if he registered it as a trade mark, that result would not follow. The question was, ought he to be able to register the fancy name as a trade mark or not? Ought he to obtain a greater monopoly by registering a trade mark than by taking out a patent? Some day the important question might arise with regard to zoedone, and other articles of that description, whether anybody might not make them and sell them under the same name. That question ought not to be left in doubt, but to be decided by legislation as soon as possible. Another point was with regard to piracy, and it seemed to him that as the law now stood, pirates had a great advantage. If several pirates chose to combine and send in representations of a mark for registration, alleging user, which, no doubt, they could do, although it was a piracy, they would deprive the legitimate owner of his right to the mark; and would make what was private property common property. He believed that had been done extensively in the case of cotton marks, and might be done in other classes; and it evidently required some legislative remedy. It had been laid down by the Commissioners of Patents that three marks of a similar character might be registered; that principle had never been recognised by any appellate Court, and some day they might be astonished to find that a mark, registered more than once, had ceased to be distinctive. With regard to British manufacturers abroad, he recollected several cases of cotton marks, where the owners of well-known marks in this country had been refused registration in Germany, because some German manufacturer chose to say that he had used the same mark in some small town in that country, on some reels of cotton. He would suggest that it would be well to bring before the Government, whenever the Trade Mark Act was altered, the importance of endeavouring to come to some agreement with all those countries with which we had trade mark treaties, as to what was a trade mark, and to form a system by which registration in one country should be equivalent to registration in all countries, and by which the mark of a manufacturer should be protected everywhere by the mere fact of being registered in his own country.

Mr. Sebastian said the first remark which occurred to him was with reference to the jurisdiction of the Commissioners of Patents. They gave instructions to the registrar as to the manner in which he should carry out his duties, and in the first case which came before the Court, Vice-Chancellor Malins seemed to think that their decision was final; but it was not held to be so now; and the question really was what their jurisdiction amounted to. There was a case in which they instructed the registrar not to register any marks consisting of foreign words or letters, and he accordingly refused to register the word Todd, which was the name of a maker of watches, and was also an Arabic word, meaning mountain. The Court, however, directed him to register it; the registrar appealed, acting, no doubt, under instructions from the Commissioners, but the Court of Appeal affirmed the decision, and the mark was registered. There the instructions of the Commissioners went for nothing; and this question was of importance with regard to point of three owners registering the same mark. The Commissioners had given

instructions that three persons might be registered, but there was no authority for that in the Act, or in the rules. As Mr. Johnson had suggested, it might be useful if some enlarged powers were given to the registrar with regard to altering the register in unimportant particulars, without an application to the Court, though he had not the same dread of that process as Mr. Johnson seemed to have. Enlarged powers might also be given to the Court for rectifying the register. One member of the firm carrying on a very extensive business, registered the firm's trade mark in his own name, for the benefit of the firm, the other partners co-operating with him, and it was held that that registration could not be transferred into the name of the firm. He thought too much attention was paid to the office fees; and with regard to costs, the Court had looked rather too tenderly after the interests of the office. When the Court reversed the decision of the registrar, and ordered a mark to be registered which he had refused, he not only paid no costs, but was paid his own. He (Mr. Sebastian) thought it was a mistake that fancy names should not be registered, as they were in almost all foreign countries, and as they were here in the case of old marks. Of course there was the difficulty which had been mentioned with regard to patent articles under fancy names obtaining greater protection than the Patent-law allowed, but there might be a power of discriminating between fancy names which would become descriptive of the article and those which could not become so. As to the custom which had been referred to, of registering fancy names in connection with a signature, it was to him very difficult to understand how words registered under such circumstances could be protected. The Act said that a trade mark should consist of certain essential particulars, in which these fancy names were not included, though a signature was; and it went on to say that, to such essential particulars, certain immaterial matters might be added. He did not understand how an immaterial addition could be protected. A great many people thought they ought to be protected, but the question was whether they were so at present. In the only decision yet given by the House of Lords on the Act, it was held that such immaterial additions to the signature ought not to be registered. It had been suggested that the object might be attained by registering a device, such as the head of some animal, thus causing the article to acquire the name of the animal; and a very recent case had shown the force of that observation. One man registered a bulldog's head, and another used a terrier's head, but the article to which the mark was attached had become known in the market as dog's head ale, and the result was that one dog's head excluded from registration another dog's head, which was totally different.

Mr. E. J. Watherston said that it appeared to him that the gist of the able paper they had listened to was contained in the concluding paragraph, just as that of most petitions was contained in their prayer. The moral, both of the paper and the discussion which had followed, proved most conclusively the necessity for a Minister of Commerce. This subject had been discussed, time after time, not only by the Society of Arts, but also by the Social Science Association, and by the various Chambers of Commerce throughout the country. The fact was that Parliament had no time to discuss questions of trade interest. It was necessary, therefore, that such subjects should previously have been considered by a Government department, and that a proper digest should be prepared by those best calculated to frame legislation. There were two Bills now before Parliament of a similar character, in regard to Copyright and Patent - laws, which should be considered together with the laws relating to trade marks. In compliance with the expressed desire of the author of the paper and a previous speaker, he would, as a member of the Council of the National Chamber of Trade, offer the services of that association, by whom an effort would be made to give effect to the proposals contained in the paper, in order that public opinion might be formed upon the subject.

Mr. Israel Davis was much gratified at finding the necessity for unifying the definition of a trade mark throughout the world so generally recognised. He did not know whether any practical suggestion had been thrown out how this could be accomplished, but a precedent existed in the action of one of the Government departments, in carrying out a similar object. It was necessary to introduce a uniform code of signals for vessels, and that had been done amongst all the nations of the world which had any commerce, by the agency of the Board of Trade. After long and complicated negociations, a general code of signals and a rule of the road at sea had been adopted, to which all nations gave in their adhesion; and not only was that effected once, but afterwards, when it became necessary to change the rule of the road, new negociations were set on foot, and the rule was changed with unanimous concurrence. This precedent was an encouraging one, and tended to show that it was not impossible to attain the great object of a uniform definition of a trade mark, which should bind the industries of all the countries of the world. Whether they should adopt the suggestion thrown out by Mr. Willis-Bund that registration in one country should be equivalent to registration in all, was another question, and he should be inclined to dissent from that view. It would be very hard that a trader in Spain should be bound to know all the marks which existed on the London register, or that a trader in Paraguay should be bound to know of all the marks existing in Melbourne; nor was it at all necessary that all marks should be registered in foreign countries. Many trade marks were used for articles which were only used in the vicinity of the manufactory, while others went all over the world; and there might be an option, and a different scale of fees for marks used only in the home trade, and for those which should apply in all the countries which belonged to the trade mark convention. That point, he thought, might be left to take care of itself. The first step would be to get the Board of Trade to endeavour to obtain a universal definition of a trade mark; and he thought the Society of Arts might usefully bring the matter before the Government. Allusion had been made to unregistered trade marks, and the certificate of refusal, which was found not to be so efficacious in foreign countries as might have been expected. Here it left the manufacturer free to bring an action against an infringer, but, abroad, it did not furnish that evidence of title which the foreign registration office required. It occurred to him that a very simple alteration would meet the difficulty. If the rule could be altered, so that instead of giving a certificate of refusal, the office issued a certificate of registry without prejudice, or of provisional registry, or some kind of certificate showing the mark was in a different class from others, but still that it had been registered, he thought the difficulty would be got over.

Mr. Johnson, in reply, said he was sorry to hear from Mr. Salaman that so much difficulty existed in Holland and Denmark. He quite agreed with Mr. Davis, that the form of certificate of refusal might be improved; at present it was a most bald document, simply stating that registration had been refused, with no explanation; and one could well understand that, when presented to any foreign Court, so far from being of any service in establishing the authenticity of the mark, it acted prejudicially. It might, at any rate, be altered so as to express on the face of it why it was given, instead of a certificate of registration; that the mark was not registered simply as the result of accident, rather than from any impropriety in the mark itself, or any wrongful claim on the part of the owner. He thought countries which had lately introduced registration of trade marks might reasonably have provided for recognising all old marks

registered in other countries, and, in fact, have confirmed them. They ought, as juniors in the matter, to have respected their seniors, and thrown no obstacles in the way of old marks recognised elsewhere. Mr. Bund's remarks as to a triumvirate of pirates were very important; and the fact that such combinations really had occurred was the strongest possible reason for the matter being reviewed. The distinctions between old and new marks were certainly most complicated, and as there were so many different kinds of marks, it was really very difficult to know what was a trade mark, and what was not. The question of costs, to which Mr. Sebastian had alluded, was one on which the public felt very keenly. It was very hard that the refusal of the registrar, from some informality, or some peculiarity in the interpretation of the Act, should involve an application to the Court, and, if the registrar persisted, an appeal, and, finally, an appeal to the House of Lords, and yet that the unfortunate applicant, though successful, should have to pay three sets of costs twice over. With reference to fancy names, Mr. Sebastian was evidently of opinion that they were not properly registered at all, but if that view were correct, why should they get on the register? He could not understand why they should get on the register, and yet obtain no status by being there. It would certainly be a great advantage to have a test case tried, and if a committee were formed, which he hoped might be the outcome of the present discussion, and if they could get up a test case, involving all the points which they could possibly combine in it, it would be of great value. They could bring it first before the Master of the Rolls, then before the Appeal Court, and ultimately before the House of Lords, and thus get many of these difficult questions decided.

The Secretary said he had no doubt the Council of the Society of Arts would give very careful consideration to any application which might be made with reference to the formation of a committee on this important question.

The Chairman then proposed a vote of thanks to Mr. Johnson for his able paper, and for the impetus which he had given to a movement which it was to be hoped would not end that evening. It seemed to be the general opinion that an association or committee should be formed to see in what way the working of the Trade Marks Acts could be improved, and how difficultie which had arisen under the existing system could be met, and it would be very satisfactory indeed if such a practical result should follow from the reading of the paper.

The vote of thanks was carried unanimously, and the proceedings terminated.

GENERAL NOTES.

Iron and Steel Institute.—The annual meeting of this Institute will be held on Wednesday, May 4th, and two following days, in the hall of the Institution of Civil Engineers. The president elect (Mr. Josiah T. Smith) will deliver his inaugural address on the first day.

Lectures on Plumbing.—A course of six lectures on "The Science and Art of Sanitary Plumbing" will be given under the auspices of the National Health Society by Mr. S. Stevens Hellyer, at the House of the Society of Arts, on May 17, June 1, 14, 28, July 12, 28, at 7.30. p.m. The lectures will be especially addressed to working plumbers, and illustrated by examples, diagrams and working models, and demonstrations. Examinations of a practical nature will be held at the close of the course, and two large silver medals, several smaller silver and bronze medals and certificates of proficiency will be awarded by the National Health Society.

Copyright Bill.—A meeting of the Law Amendment Society will be held on Monday evening, May 2, at 8 p.m., at 1, Adam-street, Adelphi, when a discussion on the Copyright Bill promoted by the Society, will be opened by Mr. John Westlake, Q.C., LL.D. Lord Reay will take the chair.

Royal Albert Hall.—Amongst the arrangements for the season at the Royal Albert Hall, it is announced that eight oratorio concerts will be given, at which Mr. Sims Reeves will sing in oratorio for the last time. The first of these concerts was held on the 27th of April, and the last will be on Saturday morning, the 9th of July. It is stated that at this last-mentioned concert Mr. Sims Reeves will make his last appearance in oratorio.

Iron Sleepers.—In this country iron sleepers have only been used experimentally, but in Belgium and Germany they have been employed for a considerable time. In the past two years it is calculated, say Messrs. Bolling and Lowe in their report, that nearly 130,000 tons have been placed on the German railways. In Germany there are many hundred miles of line running through sandy districts, for which the iron sleeper is said to be well suited.

Blast Furnace Cinder, so long regarded as a waste product, is thus treated at the Sclessin Iron Works near Liége, Belgium. The molten *slag*, as it is commonly, though inaccurately called, flows direct from the blast furnace into a stream of cold water, whereby it assumes a finely-divided condition, like coarse sand. It is raised by an elevator, deposited in wagons, and sent away at once, to serve as railway ballast for which purpose it is well suited.

Artificial Stone.—In the report on the Exhibition of Applied Science, Paris, 1879 (*Journal* vol. xxviii, p. 164), the articles of artificial stone, by M. Dumesnil, were referred to. This substance is composed as follows:—In 500 litres (110 gals.) of water, are dissolved 7 kilos. (15½ lbs.) of alum, 6 kilos. (13¼ lbs.) of slaked lime, and 1 kilo. (2¼ lbs.) of yellow ochre, to which is added 1 kilo. of glue dissolved in 5 litres (1 gal.) of hot water. In this mixture, 900 litres (198 gals.) of plaster of paris are tempered, and then half that quantity of fine river sand, free from clay, is added. This preparation, run in moulds, sets in about twelve hours, and acquires great hardness. To protect the building blocks, thus obtained, from the action of rain, it is sufficient to give them three coats of silicate of potass dissolved in water.

Tobacco in France.—The following table from a recent report shows that the consumption of tobacco in France has been steadily increasing:—

	Population.	Amount consumed. Kilogrammes.	Amount per head. Grammes.
1815	29,250,000	8,981,403	307
1826	31,673'853	11,595,084	366
1831	32,731,256	11,071,088	338
1841	34,018,715	16,461,934	484
1851	35,546,919	19,718,089	555
1864	37,133,424	28,019,803	755
1866	37,807,203	30,627,663	810
1872	35,844,414	27,031,000	754
1876	36,643,087	31,188,846	851

The amount consumed in the different departments varies very much. Snuff-taking is most practised in Oise, Seine Inférieure, Eure, and Eure-et-Loir, at the maximum rate of 375 grammes per head; and least in the departments of Doubs, Pyrénées Orientales, Nord, Haut Rhin, and Haute Savoie, where the average is but 100 grammes. In smoking, however, there is rather a reverse order of things, the Nord, Haut-Rhin, and Pas-de-Calais consuming at the rate of two kilogrammes per head, while the minimum is found in Haute Savoie, Cantal, Corrèze, Creuse, Aveyron, Dordogne, Lot, and Lozère. Ten departments only consume tobacco above the average, while 70 are actually below it. If all France smoked the same quantity as do the people of Nord, Haut-Rhin, and Pas-de-Calais, the consumption for the whole country would be 73,286,174 kilogrammes, instead of 31,000,000; and *vice versa* it would be only 6,265,963 kilogrammes if calculated according to the average of Lozère, which is only at the rate of 171 grammes per head.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

May 4.—"Buying and Selling; its Nature and its Tools." By Professor Bonamy Price, M.A. Lord Alfred S. Churchill will preside.

May 11.—"The Manufacture of Glass for Decorative Purposes." By H. J. Powell (Whitefriars Glass Works). William Spottiswoode, LL.D., P.R.S., will preside.

May 18.—"The Electrical Railway, and the Transmission of Power by Electricity." By Alexander Siemens. Dr. Siemens, F.R.S., will preside.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

May 10.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

May 12.—"Recent Progress in the Manufacture and Applications of Steel." By Prof. A. K. Huntington.

May 26.—"Telegraphic Photography." By Shelford Bidwell. Prof. W. G. Adams, F.R.S., will preside.

Indian Section.

Friday evenings, at eight o'clock:—

April 29.—"The Building Arts of India." By General Maclagan. Andrew Cassels, Member of the Indian Council, will preside.

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B. Sir Rutherford Alcock, K.C.B., will preside.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Four Lectures.

Syllabus of the Course.

Lecture III.—May 2.

Fringes. Twisted thread-work in England in the 15th century. Early designs for plaited and twisted threads. Italian, Flemish, French, and English pillow lace. Laces of primitive design.

Lecture IV.—May 9.

Resumé as to styles of design in hand-made lace. Traditional patterns. Sketch of the development of inventions for knitting and weaving threads to imitate lace. Differences between machine and hand-made laces. Modern hand-made laces at Burano, Bruges, Honiton, &c.

This course will be illustrated by specimens of lace. Diagrams and photographs enlarged will be shown by means of the lantern and oxyhydrogen light.

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

May 16, 23, 30.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 2nd...**SOCIETY OF ARTS,** John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Alan S. Cole, "The Art of Lace-making." (Lecture III.)

Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. T. Duckham, "The Effect of Land being Owned by Corporate Bodies."

Royal Institution, Albemarle-street, W., 2 p.m. Annual Meeting.

Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. G. M. Freeman, "Land Law Reform."

Medical, 11, Chandos-street, W., 8½ p.m. Annual Oration.

Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Rev. W. D. Ground, "An Examination of the Philosophy of Mr. Herbert Spencer."

Law Amendment Society, 1, Adam-street, Adelphi, W.C., 8 p.m. A Discussion on the "Copyright Bill" now being promoted by the Society, to be opened with a statement by Dr. John Westlake.

Tuesday, May 3rd...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Non-Metallic Elements." (Lecture II.)

Central Chamber of Agriculture (at the House of the Society of Arts), 11 a.m.

Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. Walter R. Browne's Paper, "The Relative Value of Upland and Tidal Waters in Producing Scour."

Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.

Biblical Archæology, 9, Conduit-street, W., 8 p.m. 1. Mr. Ernest de Bunsen, "The date of Menes." 2. Prof. A. Eisenlohr, "An Historical Inscription."

Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. W. N. Parker, "Some Points in the Anatomy of the Cæcum in the Hare and Rabbit." 2. Prof. F. Jeffrey Bell, "Contributions to the systematic arrangement of the *Asteroidea*. Part I., "The species of the genus *Asterias*." 3. Dr. M. Watson, "Additional Observations on the Anatomy of the Spotted Hyæna." 4. Mr. Oldfield Thomas, "The Indian species of the genus *Mus*."

Wednesday, May 4th...**SOCIETY OF ARTS,** John-street, Adelphi, W.C., 8 p.m. Prof. Bonamy Price, "Buying and Selling; its Nature and its Tools."

Iron and Steel Institute, 25, Great George-street, S.W., 10½ a.m., General Meeting of Members. The President-Elect (Josiah T. Smith, Esq.) will deliver his Inaugural Address. A Selection of Papers will be read and discussed.

Entomological, 11, Chandos-street, W., 7 p.m.

Archæological Institute, 16, New Burlington-street, W., 4½ p.m. Annual General Meeting.

Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

Thursday, May 5th...Royal, Burlington-house, W., 4½ p.m.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Prof. Bayley Balfour, "The Dragon's Blood Tree and its Products." 2. Prof. G. Busk, "New Species of *Cellepora* from the *Challenger* Expedition." 3. Prof. Bayley Balfour, "New Genera of Plants from Madagascar."

Chemical, Burlington-house, W., 8 p.m. 1. Ballot for the Election of Fellows. 2. Mr. E. W. Prevost, "The Action of Humic Acid on Atmospheric Nitrogen." 3. Mr. R. T. Plimpton, "The Active and Inactive Amylamines." 4. Mr. L. D. Thorne, "The Products of the Action of Alkalies on Ethyl β. Ethylaceto-succinate." 5. Mr. T. Purdie, "The Action of Sodium Alcoholates on Fumaric Ether."

South London Photographic (at the House of the Society of Arts), 8 p.m.

Royal Institution, Albermarle-street, W., 3 p.m. Prof. Tyndall, "Paramagnetism and Diamagnetism." (Lecture II.)

Iron and Steel Institute, 25, Great George-street, S.W., 10 a.m. Reading and Discussion of Papers continued.

Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Annual Meeting.

Friday, May 6th....Royal United Service Institute, Whitehall-yard, 3 p.m. Captain J. T. Bucknill, "The Protection of Buildings from Lightning."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. The Hon. George Brodrick, "The Land Systems of England and of Ireland."

Geologists' Association, University College, W.C.

Philological, University College, W.C., 8 p.m. Mr. R. Martineau, "The Rhæto-Romanic Dialect." (Part IV.)

Iron and Steel Institute, 25, Great George-street, S.W., 10 a.m. Reading and Discussion of Papers continued and concluded.

Quekett Microscopical Club, University College, W.C., 8 p.m.

National Health Society, 23, Hertford-street, W., 4 p.m. (Drawing-room Lectures.) Mr. C. N. Cresswell, "Sanitary Relations of Local Self-Government."

Saturday, May 7th...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Henry Morley, "Scotland's Part in English Literature." (Part II.)

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FRIDAY, MAY 6, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third lecture of the fourth Course on "The Art of Lace-making" was delivered by Alan S. Cole, on Monday, 2nd inst. Attention was drawn to the gradual growth of design, as exhibited in the history of Italian, Flemish, French, and English pillow lace, and the distinctive characteristics of Mechlin, Brussels, and Valenciennes lace were pointed out. A series of specimens of lace were exhibited, and enlarged photographs of representative pieces were shown by means of the lantern and oxy-hydrogen light.

ART FURNITURE EXHIBITION.

The preparations for the Exhibition of Works of Art applied to Furniture at the Royal Albert Hall are now being proceeded with, and it is expected that the Exhibition will be opened on Thursday, 12th May, at the same time as the General Art Exhibition at the Albert Hall.

PROCEEDINGS OF THE SOCIETY.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday, April 28, 1881; Allen Thompson, M.D., F.R.S., in the chair.

The paper read was on—

THE IMPURITIES IN WATER, AND THEIR INFLUENCE UPON ITS DOMESTIC UTILITY.

By George Stillingfleet Johnson, M.R.C.S., F.C.S.

There are some impurities found in the water of rivers, more especially in those rivers which, like that in the immediate neighbourhood of this building, take their course through large towns, concerning which I shall have little to say this evening. I allude to organic impurities, the detritus of living beings, sewage, and the like, and my reason for keeping silence upon this great subject is the incompleteness of our knowledge regarding it. Our highest medical authorities seem to be at variance as to the nature and degree of the baneful influence exerted by those impurities which I have mentioned upon the human economy, with the exception of the so-called specific poisonous products of such diseases as typhoid and cholera; and our highest chemical authorities are very much at variance as to the best method of estimating or determining the amount of these organic pollutions in waters, as they also are in the various accounts they give of the processes by which nature removes them. It would ill become me, therefore, to do more than hint at the existence of this source of contamination of water, unless I stood prepared to bring forward some new facts or experiments throwing light upon the subject, which I am not in a position to do. I must, therefore, confine myself this evening to the discussion of some of the more important inorganic impurities contained in natural waters, and their influence upon the domestic utility of the inportant liquid which contains them.

The word "impurities" has occurred several times already in this paper. I have also spoken of "pollutions" and "contaminations," all of which expressions tend to convey the idea that the presence of substances so described, in the water we drink and employ for household purposes generally, must needs be injurious and prejudicial. Now, the tendency of this paper will rather be to show the great usefulness of many of these so-called "impurities" in natural waters; and the word is used here in its strictly chemical sense, to indicate anything which we find in and accompanying water which is not the chemical compound, H_2O.

Pure water, the compound containing two atoms of hydrogen combined with one atom of oxygen, is a pure chemical substance which is never found in nature. We explain this by the statement that water exerts a solvent action upon various gases and solids.

It is, then, by virtue of its solvent action that water becomes impregnated with the impurities of which I am to speak; and I will, therefore, ask you to follow me while I make a few preliminary remarks upon, and show you a few experiments illustrating, the nature of solution. The process of solution consists essentially in a change of physical state, without alteration of chemical constitution. Thus, when sugar or common salt is dissolved in water, we can obtain the solid sugar or chloride of sodium by simply evaporating the water; and these are instances of true solution; but, if metallic copper be dissolved in nitric acid, that is an instance of solution accompanied by chemical change; for, if we evaporate the blue liquid thus obtained, we have a deposition, not of metallic copper, but of nitrate of copper, the salt formed by the chemical action which takes place between that metal and nitric acid. Solution proper, then, consists in a change of physical state simply without change of chemical constitution. Now, we know of but three physical states in which matter can exist, the solid, the liquid, and gaseous. The solvent or substance which brings other substances into solution is usually a liquid. The dissolved body may be either a solid or a gas.

Now, the physical state in which we find any

substance depends to a great extent upon the nature and intensity of the physical forces which happen to be acting upon it at the time. Besides the action of solvents, the two physical forces, heat and pressure, exert a powerful influence upon the physical state of matter. The essential difference between the three physical states of matter is one of the relative freedom of motion which exists between the molecules or ultimate particles of which the matter consists, the gaseous form of matter possessing the greatest, whilst the solid possesses the smallest, degree of molecular mobility. Heat, on the one hand, increases this mobility of the molecules of matter, whilst pressure has the reverse effect.

Next, observe that the solvent (liquid water, *e.g.*) is in the intermediate condition, as regards molecular mobility, between the solid and the gas, whose physical state it must assimilate with its own before it can bring them into solution. It follows, then, that the liquid solvent must bind a gas in chains, as it were, must diminish the free mobility which exists among the particles of that most elastic form of matter, whilst it will have to increase the molecular mobility of the comparatively sluggish solid, in order to make them respectively assume its own physical state. Accordingly, we should expect to find that a liquid will have its solvent action upon solids increased by the application of heat, whilst its power of dissolving gases will be diminished by heat, but improved by pressure. And these laws are obeyed in almost all instances.

I will now show you one or two experiments, to illustrate these preliminary remarks upon solution. When I stir up these two white powders in separate beakers of hot distilled water, you observe that one of them (which is powdered sugar) becomes readily incorporated with the water, changes its physical state, assuming that of its solvent, is dissolved. That is an instance of a soluble substance. This other powder, however, refuses to do anything but remain partially suspended in the water, making the liquid look milky, whilst the greater part of it (for it is very heavy) sinks and remains at the bottom of the beaker. It is the salt called sulphate of baryta, and is one of the most insoluble bodies known.

To illustrate the effect of heat in assisting the solution of a soluble solid substance in a liquid, it will be sufficient to cool this hot saturated solution of iodide of lead, when we find that water, which was capable of retaining a large quantity of that salt in the liquid state whilst hot, becomes incapable of doing so as it cools, and the excess of salt separates out from the solution in the crystalline form.

To demonstrate the action of heat in retarding the solution of a gas in a liquid, I will first pass up a little water into this tube (which contains dry ammonia gas confined over mercury). As soon as the water reaches the gas, you see that the latter disappears, being dissolved by the water. Now, if I pour a little hot water over the outside of the tube, we shall soon see the effect of heat in increasing the molecular mobility of the ammonia, for the restraining power of the water, at this high temperature, becomes insufficient to control the elasticity of its volatile companion, and the ammonia bursts its chain and resumes the gaseous condition. As the tube cools again, the solvent power of the water is again triumphant, and the gas disappears. Not only does the temperature of the liquid solvent exert an influence upon the quantity and quality of the substances which it is capable of dissolving; but the solvent action of a liquid is often considerably modified by the presence therein of substances which it has already dissolved.

We will consider this influence of dissolved matter in water upon its solvent action on other forms of matter somewhat fully, since it serves to explain the presence of some of the impurities found in waters; and it will be convenient to divide the subject into two heads, viz.:—

1. The influence of dissolved gases upon the solubility of solids.

2. The influence of dissolved solids upon the solubility of other solids.

1. Excluding those cases in which a chemical action occurs, resulting in the production of some insoluble compound by the action of a dissolved gas upon one or the other of the elements present in a dissolved solid, the general tendency is for a dissolved gas to increase the solubility of solids in their common solvent. As an illustration of this, I will cover this solution of copper sulphate with a strong solution of ammonia gas in water. You see now three layers in the containing vessel. Below the blue solution of copper sulphate, above the colourless solution of ammonia gas in water, and between the two, a light blue turbid layer, the turbidity of which is due to the presence there of suspended hydrated oxide of copper, a substance which is insoluble in pure water, and in most neutral and alkaline solutions, but which is soluble in a solution of ammonia gas in water, yielding a dark blue liquid, which you see is produced when I stir up the contents of the beaker. There are other instances which will occur to every chemist, of solid bodies quite insoluble in pure water, yielding to the solvent action of a solution of ammonia gas in water. It appears, then, that the dissolved gas confers a degree of molecular mobility upon the water which has dissolved it, or at least enables that water to produce the requisite freedom of motion amongst the molecules of an otherwise sluggish solid, which is necessary in order to compel it to assume the liquid state.

2. It is frequently observed, and especially amongst the halogen group of elements, that an insoluble salt is rendered soluble by the presence in their common solvent of a very soluble solid body. One of the most striking and beautiful examples of this is seen in the case of the red mercuric iodide, which is entirely insoluble in pure water, but is readily dissolved by water saturated with potassic iodide—a very soluble salt. It is essential that the potassic iodide be present in a somewhat concentrated solution, for, as you see in this beaker, when a solution of mercuric iodide in one of potassic iodide is mixed with a large bulk of pure water, the red mercuric iodide separates out. If there be any chemical action between the two iodides in this case, it is of the very feeblest kind. Indeed, some experiments of my colleague, Mr. J. M. Thomson, have tended to show that, if the double salts formed by dissolving insoluble halogen compounds in soluble ones be compounds at all, they are molecular, not atomic combinations.

It is, at all events, interesting to remark, that when a dissolved solid assists the solution of another solid body, it is the more soluble substance—that which is endowed with freest molecular mobility—which serves to bring about the liquefaction of the more sluggish solid; and there are instances of this action which cannot be at all explained by chemical action, as in the case of the solubility of quick lime in a strong solution of sugar.

It sometimes happens that the action of a solvent is arrested, by the formation of a protecting film of an insoluble substance upon the surface of an immersed solid. Thus, marble, which is a compact crystalline variety of carbonate of lime, is freely dissolved by a solution of hydrochloric acid gas in water, the only solid product of the accompanying chemical action being the salt known as calcic chloride. Now, calcic chloride is freely dissolved by water, and, as each particle of it is formed on the surface of the marble, it is dissolved off by the water, and fresh surfaces of marble are constantly exposed to the action of the hydrochloric acid. But, if we immerse marble in water containing both hydrochloric acid and sulphuric acid in solution, its surface speedily becomes covered with an insoluble film of calcic sulphate, and the action ceases. Marble is still there in abundance; hydrochloric acid is also present in quantity, adequate and sufficient for its solution; but, by reason of the intervening insoluble film of calcic sulphate, they are prevented from acting upon one another. "The chemical force can only act at infinitesimally small distances." Another instance of the protecting action of an insoluble film upon the surface of an otherwise soluble solid is seen in the case of the black ferrous sulphide. When this substance is acted upon by sulphuric acid, the salt known as ferrous sulphate is produced. Now, green vitriol, or ferrous sulphate does not dissolve in cold, strong sulphuric acid, but it dissolves readily in hot dilute sulphuric acid. When, therefore, I pour cold oil of vitriol over this ferrous sulphide, there is little or no action, a film of ferrous sulphate forming on the surface of the sulphide, and protecting the sulphide beneath from the action of the acid; but when I pour water into the containing vessel, a brisk action is at once set up, heat being developed by the admixture of the water with the acid, cold strong sulphuric acid being converted into hot dilute sulphuric acid, which dissolves off the ferrous sulphate as fast as it is formed.

I will now pass on to a consideration of some of the impurities contained in natural waters—in water as it is supplied to us for use in every-day life—explaining, where that is possible, the sources and method of contamination, and, further, discussing the chief precautions necessary for the removal of such impurities as are prejudicial to the domestic utility of this valuable agent. First, then, we will consider the gas found in solution in natural waters, With some trifling exceptions, viz., some of the rarer mineral waters, the gases dissolved in water are those which are present in our atmosphere—oxygen, nitrogen, carbonic acid, and ammonia. The oxygen and nitrogen gases, the elementary constituents of the atmosphere, are present in it in invariable quantities, and are far less soluble than the other two.

The carbonic acid and ammonia, or compound gases, are chiefly products of animal life, and are constantly being removed by plants and vegetable organisms, but they are also more soluble in water than the first two. The carbonic acid is present in larger proportion than the ammonia, whilst it is also far less soluble than the latter gas. Indeed, after a long continued fall of rain, the presence of ammonia in the air of a place is hardly recognisable.

Spring-waters are very apt to contain much larger quantities of CO_2 than rain-water or river water. Meandering, as they frequently do, through subterranean passages, they are exposed in their course to influences peculiarly favourable to their conversion into strong solutions of this gas. The earth being the common receptacle for dead organic matter, and her cavities being in many cases never penetrated by the sun's rays, or ventilated in any way, accumulations of carbonic acid are to be expected in these regions. The water, then, which is often very cold (it may be produced by melted snows), is churned up at frequent intervals along its course with these terrestrial gases, and becomes, in consequence, highly charged with them.

We are able to demonstrate the presence of dissolved gases in water, by simply boiling it in an apparatus such as this which I now show you, and collecting the permanent gas which escapes, as is being done here. The presence of these dissolved gases in water appears to be in every way beneficial. If we consider water as a beverage, the sparkling and refreshing effect of spring-water is largely due to the dissolved gas, especially to the carbonic acid gas which it contains. Again, boiled or distilled water, from which the gases have been expelled by heat, is mawkish and insipid, but may be again rendered palatable by aërating it with charcoal. But more than this, absolutely gas-free water (which, however, can only be obtained by boiling water in vacuo), boils at a temperature considerably above 100°C., and with violent explosion.

Again, it is probable that the oxygen dissolved in water oxidises, and removes some of the more readily putrescible organic matters contained therein; and it certainly is of the utmost importance to the life of fish. The dissolved gases in water also exert an important influence upon its solvent action for solids, as we shall now find. The solid substances dissolved in waters are generally chlorides, sulphates and, carbonates of the alkalies, and of the alkaline earth metals.

Those waters which contain the alkaline earths in solution, are divided into (1) calcareous and (2) magnesian waters, the former containing sulphate or carbonate of lime in solution, the latter sulphate or carbonate of magnesia. Such waters are said to be hard. Now, it is in the case of the carbonated calcareous and magnesian waters that we observe most distinctly the influence which a dissolved gas may exert in modifying the solubility of a solid in their common solvent. For the carbonates of lime and magnesia are insoluble in pure water, or nearly so; but considerable quantities of these salts may be brought into solution by water charged with carbonic acid gas. For instance, if I bubble carbonic acid gas through this clear lime-water, we first observe a milkiness, due to formation of the insoluble carbonate of lime; and on continuing to pass the gas, we finally obtain a clear solution. The dissolved

gas enables the water to overcome the molecular sluggishness of the calcic carbonate, and to reduce it to the liquid condition; just as the dissolved ammonia gas in our previous experiment enabled the water to hold in solution the hydrated cupric oxide. Now, if I boil this clear solution of bicarbonate of lime, the excess of gas is expelled by the heat (just as the ammonia gas was expelled from its dissolving water when the temperature of the tube containing the solution was raised), and the water, no longer aided by the mobile carbonic acid gas, loses its power of keeping the calcic carbonate in the liquid state; accordingly that salt is reprecipitated.

Bearing the facts in mind, we shall be able to explain some of the phenomena of nature in connection with this subject of calcareous waters. We have seen that spring-waters are frequently highly charged with carbonic acid gas; now carbonate of lime, in the shape of chalk deposits and limestones of various kinds, is a very constant ingredient of the soil in many parts of the earth's surface. It must, therefore, be a matter of very frequent occurrence for water, already highly charged with carbonic acid gas, to come in contact with carbonate of lime in the course of its subterranean wanderings; hence the frequent contamination of natural waters with dissolved carbonate of lime. But there is another interesting and very beautiful phenomenon which we are enabled to explain by the light of the above facts. I mean the formation of stalactites and formations such as are figured in the diagram on the wall. Suppose a water holding in solution much carbonate of lime and carbonic acid gas to trickle slowly through the roof of a cave. From each drop of water, as soon as it finds itself exposed to the common air, some of its dissolved carbonic acid gas will begin to evaporate, and for each molecule of gas which thus leaves the water, a molecule of calcic carbonate will be deposited in the solid form. Let a few of these solid particles adhere to the roof of the cavern, and from the nucleus thus formed, the production of vast conical masses, such as are here pourtrayed with their beautiful tapering apices pointing towards the earth, is only a matter of time. The nature and quantity of the dissolved salts in spring water will, of course, vary with the composition of the soil through which it has passed. Many mineral waters are of great medicinal value.

We will next consider the influence of dissolved lime-salts upon the domestic utility of water. Is "hardness" in water prejudicial? If we consider the water as a beverage, the answer would be, No. The worst that hard waters have been accused of is that they produce a tendency to calculous formations in those who drink them. But I think the water-drinker may answer to that charge, "Not proven." And, on the other hand, we cannot but remember that the metals calcium and magnesium, in combination with phosphoric and carbonic acids, play the important part of conferring the requisite degree of hardness and stability to our frame—are, in fact, the earthy constituents of the skeleton. But there is another purpose for which water is employed, viz., for washing, and which is hardly less important than that we have just considered. For this purpose hard water is certainly disadvantageous.

Soap contains fatty acids, which form insoluble compounds with the lime and magnesia in hard waters, and no lather will be produced till all the lime and magnesia dissolved in the water have been precipitated in this way. And this occasions a waste of soap.

Now, what is called the temporary hardness in water may be removed by boiling it. The expulsion of the dissolved carbonic acid gas by that means, leads to the removal of the calcic carbonate from solution in the water, and the hardness due to that cause is then removed. But the water may contain sulphate of lime in solution, which will not be removed by boiling the water. On the contrary, unless the water had been previously saturated with the salt, the evolution of steam in boiling would rather tend to concentrate its solution, and thus the permanent hardness due to this cause would remain. Moreover, there is a further objection to boiling water (except in small quantities) for the purpose of removing its hardnes, since, besides the consumption of fuel which is necessarily incurred, the deposited calcic carbonate tends to form boiler incrustations, often of considerable thickness, upon the walls of the vessel employed for the purpose, and if they do not lead, as they have too often done, to dangerous accidents by their suddenly becoming detached, and producing explosive bursts of steam, by allowing the water to come in contact with the strongly heated metal wall of the vessel, yet must invariably cause great waste of fuel, owing to their inferiority as conductors of heat. Therefore, the process of Mr. Clark, which is conducted without any application of heat at all, was a great boon to mankind, especially as it has the additional advantage of clarifying a water as effectually as any filter.

The problem before us is essentially this. How may dissolved calcic (and magnesic) carbonate be best removed from solution in water? *i.e.*, how may these salts be converted into suspended and insoluble matter with the smallest possible expenpiture of time and money? We have seen that the method of boiling the water, though effectual, is objectionable on the score of expense, liability to accidents, &c. Now, in Mr. Clark's process, which I have said is preferable, the suspended insoluble calcic carbonate produced has to be removed by subsidence. There are two methods by which suspended matter is removed from water in nature, subsidence and filtration, and these processes are also adopted by man for the same purpose. Now, it is claimed for the method of purification by filtration that organic matters are oxidised by the substances employed, *e.g.*, charcoal, which has the property of retaining oxygen gas in its pores. But the process of Mr. Clark also undoubtedly removes dissolved organic matters from waters, the lime which is added acting as a mordant, and producing their precipitation. Mr. Clark's process is as follows:—By adding quick lime or hydrated (slaked) lime to a carbonated calcareous water, the carbonic acid gas, which is holding the carbonate of lime in solution, is first removed by combination with the added lime, and the carbonate of lime thus produced falls, together with that previously in solution, as a solid insoluble precipitate. The turbid water is left to clear by subsidence, and is afterwards drawn off freed from temporary hardness.

I have hitherto been speaking of what may be called unavoidable impurities in water — impurities, viz., which are introduced by natural processes which are beyond the control of man; but before concluding, I must allude, however briefly, to a very important accidental source of contamination of water, which is sometimes introduced by man himself, I mean the contamination of water with lead. And here we shall find that the influence of dissolved matters in any water is extremely important in modifying its solvent action upon this metal. Lead, from the ease with which it is worked, and the resistance which it offers to atmospheric action, changes of temperature, &c., has been found to be a very convenient metal wherewith to construct pipes for conveyance of water, and cisterns for its storage. But lead is dissolved in appreciable quantities by some natural waters, and the long-continued ingestion of that metal, even in very minute quantities, produces serious symptoms of disease in the human subject, so much so that the metal has given its name to at least two specific affections, lead colic and lead palsy. It becomes, then, a matter of the utmost importance to be able to state, from a knowledge of the ingredients of any given water, whether or not it will be safe for persons to drink that water after it has been stored in leaden cisterns—whether or not that particular water is likely to exert any solvent action upon the metal. This we are able, in many cases, to do. For it has been found that pure water, free from both dissolved solids and gases, has no solvent action upon lead. But water containing dissolved oxygen becomes impregnated with lead, oxide of lead being, to a certain extent, soluble in water.

1. Practical Deduction:—Rain-water, stored in lead, must not be used for drinking purposes. Again, when waters containing carbonates, and especially sulphates, in solution are stored in leaden cisterns, the metal becomes coated with an insoluble protecting film of carbonate and sulphate of lead, further action being thereby prevented, and the water does not become saturnine.

2. Practical Deduction:—Carbonated and sulphated calcareous waters may usually be stored in lead with impunity. The film which forms on the surface of the metal should by no means be removed.

3. Waters containing nitrates and chlorides in abundance cannot safely be stored in leaden cisterns, since the nitrate and chloride of lead are soluble salts. The practical deduction from this is obvious.

In concluding, I hope I have convinced most of my hearers that, though we do not drink pure water, it would be very much worse for us if we did, and that, whilst we may sometimes be inclined to ask, "Why is such a substance here?" we generally find at last that it serves some important purpose which had escaped our ken—in fact, that we are finally led to wonder at the Wisdom which works through intricate and complicated labyrinths to a perfect and simple end, and are forced to admire the ultimate tendency and result of even such seeming anomalies as the "impurities in water."

DISCUSSION.

The Chairman said, as his chemistry was of a very ancient date, he should not venture, in any remarks he might be bold enough to make, to discuss the chemical part of the subject. He had been exceedingly gratified by the lucid exposition of that part of the extensive subject which Mr. Johnson had selected, as well as by the well-devised experiments which had been performed, and which had brought out so fully the illustration of the principles laid before them. It was quite necessary to avoid, in a paper such as this, entering upon the extremely extensive and difficult part of the subject involved in the consideration of the organic impurities of water, as that could only satisfactorily be dealt with in a separate paper. A great part of his life had been divided between two residences, in which very opposite extremes in the condition of water existed, so that he had had an opportunity of observing, in a general way, the effects of these conditions. At Aberdeen he used the water of the Dee, which approached almost to distilled water, with the exception of course of the gases, and in Glasgow the water of Loch Katrine, which, was equally pure with the water of the Dee, and in both instances he was made aware of the circumstances which Mr. Johnson had so well explained with reference to the disadvantage that might arise from the purest water, more especially from the solution of the leaden pipes through which the water passed, or from the cistern in which it was kept. The introduction of slate cisterns must be considered a very great advantage, as they protected one against the risk, which might occur from keeping water for a long time in leaden cisterns. With respect to pipes, he was quite aware of the evil when they were new; and if the cistern was of slate, it was only necessary that the water should be run through the pipe a short time, in order to escape the danger which might arise from the water remaining a considerable time in the leaden pipes. He had known an instance of lead colic being produced simply from inattention to this precaution. He had also had ample experience of the process for softening water, for it so happened that the water supplied to the house in which he lived near Edinburgh was the hardest with which Professor Clark had ever come in contact. Few were aware of the evils belonging to extreme hardness of water. The water to which he referred, when used for boiling meat, had the effect of making it quite red; vegetables shrivelled up in a most wonderful way under its influence, kettles became encrusted, tea could not be made, and washing with it was quite out of the question. For the cure of this, by Dr. Clark's direction, he added a ninth part of lime water to the ordinary water, and during the night a subsidence, not only of the whole of the carbonate of lime, but of all the impurities took place, the water being then fit for domestic use. Those present must have been convinced by the author of the advantages which should belong to such impurities when occurring in a moderate degree, though they might not go to the length which the well-known old lady of St. Andrew's did, who, when great efforts had been made to introduce new water in the place of one which had not been favourably looked upon by the inhabitants before, said that she did not think much of the new water, as it had neither taste nor smell.

Mr. Lovegrove had been told that in nine cases out of ten water was contaminated in zinc cisterns, and it would be interesting to know the effect of water contaminated with zinc. A great deal had been said as to the impurity of water in daily use, and, therefore, he should like to know whether, supposing water passed through say 100 miles of iron pipes, the oxidation of the pipes would tend to improve or deteriorate the quality of the water.

Mr. Maignen said it was pleasant to find there was no great fear of mineral impurities in water doing much harm to the health of people. The germs of organic impurities caused disease, but lime did not do so except when in excess. The question of softening water was somewhat a cumbersome matter, and it might be egotism for him to speak upon the subject, as he had ventured to introduce a process to remove many impurities from water. The object of the process was to impregnate charcoal with lime, so that when the water was filtered through the charcoal, the lime in the charcoal took up the bicarbonate of lime in the hard water to a certain extent. This process could be carried on by filtration, and, through the kindness of Mr. Johnson, he had been allowed to put upon the table specimens of the filtering medium, and filters which he had patented. In the inside of the filter was a cone, the outside being covered with an asbestos bag, and charcoal being put into the water; upon its filtering, the bag became thinly coated with charcoal, which acted as an efficient filter.

Mr. Clements said that having paid some attention to the subject of impurities in water for the last few years, he found there had been many cases of disease caused by water from sewers passing through the soil into wells; and some time ago he heard of a case which occurred at Croydon, where a man had been killed by drinking this impure water. There appeared to be a considerable discrepancy in the opinion of various persons as to finding out whether water was pure or not; and, some time ago, a gentleman in the South of London sank a well to obtain water, and having procured what appeared to be clear water, he gave some to him (Mr. Clements), and, upon testing it, he found it was very bad, as compared with the water supplied by the Kent and London companies. A great deal of discussion had taken place upon the subject of impurities in water lately, and much difference of opinion existed upon the matter.

Mr. Johnson, in reply, said that as regards contamination of water with zinc, he had no experience. He spoke with some diffidence upon such a subject, seeing so many distinguished medical men present, but from what he knew he did not think that zinc was a dangerous metal, it being frequently administered medicinally, nor could he say what action water containing impurities had upon zinc. As to water passing through a long iron pipe, there was no doubt the water would have a very considerable action upon the metal. The pipe would become corroded, and the water at the point of exit would be turbid, more especially with ferric oxide. He could not say, in an off-hand kind of way, that impurities in water were always beneficial, because, in considering the question of whether water would act upon any metal, it was not sufficient to say that the water was impure. We must always consider what the nature of the impurities is. Water which was impure with carbonates and sulphates was safe to store in lead, but, on the other hand, water full of nitrates and chlorides would be exceedingly dangerous to store in lead. As regards the action of the carbo-calcis filter referred to by Mr. Maignen, no doubt it was a very good plan for the rapid filtration of small quantities of water, but the great advantage of Clarke's process was seen when enormous quantities of water were required; for instance, in the case of large institutions, where soft water was necessary. As to the organic impurities in water, he had left that out of consideration altogether. He was quite aware that the commencement of his paper was somewhat elementary, but it was impossible to avoid introducing some elementary facts, and he thanked those who possessed knowledge upon the subject for having had patience with him while he touched upon those details.

A vote of thanks to the lecturer having been proposed by the Chairman, it was carried unanimously, and the meeting adjourned.

INDIAN SECTION.

Friday, April 29, 1881; Andrew Cassels, Member of the Council, in the chair.

The paper read was on—

THE BUILDING ARTS OF INDIA.

By General Maclagan, R.E.

Everyone who has been in India has had opportunity, at some time or other, of taking notice of the buildings in the places at which he has had to take up his own abode for a time. He may, indeed, be often in places where there is not much to be seen. The ordinary dwellings of the people will not in India, more than elsewhere, present much that will be thought worth observing. Yet, even in the simplest of dwellings, one may see how much can be made of very slender local resources, and how well, under the guidance of ancient custom and personal experience, they are turned to account.

When you hear of cottage walls made of mud, the word does not sound nice to English ears. But, when you see them, you find they are something better than you thought. Put together solidly and thickly, the mud becomes one mass throughout, and, hardening as it dries, it forms a compact and effective protection against heat and against rain. In greater mass, this simple material forms the very efficient defensive works of what are well known as mud forts in India.

How simply, also, do we find roof protection supplied by a skilful use of the common reeds and grass that grow in the jungle (jungle, let it be observed, is the familiar name both for forest and all uncultivated waste, which, except in driest tracts, commonly becomes a wilderness of shrubs and thorny trees and tall grasses). A roof covering of reeds, of no great thickness, does not truly afford much protection against the sun, and will not exclude the heaviest rain; but it is very wonderful to see what it can do. At places in the hills, you shall see local material of another kind turned to account for roof covering, in a cheap and effective way; large flat slabs of easily split stone, doing duty as slates, with lumps of rock laid upon them to hold them in their place. In India, as in most other countries, there is something worth noticing in the way in which the simplest of available means and materials are turned to account in very simple ways.

In India, we notice next something more. When we get above the very lowest and poorest kinds of human habitations, we begin to see manifested a demand for some ornament. The ornament may be of a very rude character, but there it is. Something is wanted more than that the building shall serve its direct and essential purpose. You may find ornamentation given in colour or in wood-carving. The white-washed door jambs may have streaks of ochre, diversified with curved lines and spots, and sometimes more ambitious efforts of the owner or the village artist. But there is something of a higher class in the rough carvings of the lintels and the door-posts of houses in even lowly,

unpretending villages. Rough carvings, no doubt, they often are, of simple waving lines or geometric patterns, after the fashion of greater and more elaborate work in large cities. They are very unsymmetrical, perhaps, and very uneven. But this is nothing; the eye does not care to be critical in looking at these things. The ideas and aims are good, if the execution is sometimes rustic. Rustic or not, the effect is very pleasing. It admits of variety of treatment, and the treatment rises to various degrees of excellence. But the great thing is that it is the expression of a felt desire for something more than mere needs. A something pleasing to the eye has become a need, and it finds, in its simple way, on the spot, the art that is capable of satisfying the demand.

An exactly similar application of this art of wood-carving for external ornament is seen in the boats on most of the Indian rivers. In many of these boats, of which there are numerous varieties for ferry purposes, or for general traffic, there is a bit of deck at the stern, which gives the steersman his well-raised look-out, and command of the rudder, which deck is also the roof of the little shelter of his family and the cooking place. The weather-boarding which edges this bit of deck on the side towards the open body of the boat, presents a convenient surface to be ornamented with this wood-carving. A real pleasure to people who have to use these river boats, is this rude attempt at simple decoration. The crossing of an Indian river, in the course of a morning march, though sometimes a tedious and troublesome business, is oftener a very pleasing little break in the day's journey —that is when there is no unusual pressure, and things are in their normal, undisturbed state. When you have stepped on board, and your horse has been persuaded to follow, you sit down to enjoy the bit of quiet rest as you cross the steady, placid stream; no sound meets the ear but the long splash of the big oars, the young day is fresh and cool, and the low sun glances on the smooth water. It is very peaceful and pleasant; and to all the quiet enjoyment of the moment, it is something added to see this well-purposed effort of humble art among a rough and hard-working, uncultivated people. It is the sign of a love for something pretty to look at—of a care for something more than is wanted for the mere practical purposes of a safe and substantial ferry boat.

We look with some satisfaction on these lowly, but pleasing examples of unaided and unspoiled native art. Work of this kind, of all various degrees of higher merit, in point both of construction and ornamentation, will be found in the better class of private dwellings and shop fronts, in doorways, verandah posts, latticed windows, and little balconies, in the villages and towns, and even among the rude hill tribes, within and beyond our frontier. But we take our view of the building arts generally from works of a more permanent character. We attach a higher value, in certain respects, to those that have stood the test of time; that is, we look to buildings erected before our day, some of them very long ago.

There is often a sort of idea that one must go back a great way for specimens of excellence in various arts, and, among these, the arts connected with building. In India, as elsewhere, people have been in the habit of saying that no such buildings are erected now, as in the days gone by, and that certain old arts are lost. It has been concluded that the capacity for such work has died out. It is one phase of the idea prevailing in all ages that former times were better. It may be the case that we cannot point to anything in India, built within the last hundred years, to equal the grand Hindu temples of Tanjore, the Jain buildings at Abû, the Taj Mahal at Agra, the Jama Masjid at Delhi. The occasion for erecting such buildings, and the means, are wanting. We are not warranted in adding, also, the ability to design and to execute them. It is almost needless to say that for great and beautiful buildings, great expenditure of money and labour is required. It was perhaps a stern necessity that stopped the second tower alongside the stately Kutb Minâr at Delhi, and the second tomb opposite the Taj, and elsewhere left intended works unfinished. The ability was not wanting, but the means.

A wealthy prince, happily gifted with large ideas as well as despotic power, orders a work which shall be "exceeding magnifical," and it is done. The skill to plan, and the skill to execute, find full scope for all their highest ambitions. Materials are supplied without stint, of whatever kinds may be required, any number of labouring hands are collected from all quarters to order, and there is little question about cost. The will is there, and the command, and the means, and there is no hindrance. These are happy conditions for the execution of splendid works. If the work was to be a building of stately dimensions, of costly materials, and substantial construction, there you have it. For the master mind to devise and direct the whole was found with the occasion. Given the same conditions now, could India produce such works? Doubtless it could, though the master minds, of the class required, would perhaps be cramped in these days by unwholesome influences.

But besides the men, you must have suitable means to do anything really effective as well as lasting. Nothing great in building, or perhaps anything else, can be done cheaply. We remember Molière's niggardly old gentleman who wants to give an entertainment, but does not like the expense. "Can you give a good dinner for ten guests (or say eight, for what is enough for eight will do for ten)?" "Certainly," replies the *chef*, who knows him well, "if you give money enough." "There, now," says the miser's obsequious friend, who is helping to make the arrangements, "was there ever a more absurd reply? A good dinner with plenty of money! Why anybody can do that. The clever man is one who can give a first-rate dinner that costs very little." Now this is a kind of thing that has sometimes been attempted with bricks and mortar; and with no better result than was to be looked for in Mons. Harpagon's dinner. If you try to make a cheap building that shall imitate a costly one, you need not be surprised if it turns out unsatisfactory, or something worse. Is anything of this kind done now-a-days by the English folks in India? Many an engineer has unhappy experiences in this way. With the money that can be granted for a certain work—and quite truly it may sometimes be impossible to add to it—he is to carry out something

which, done as it should be done, needs more; so he has to do it as it should not be done. "His poverty, but not his will, consents." And it is the ungracious task of those over him to aid in paring down what he would like to do. It really sometimes cannot be helped. The purpose is served, at least for a reasonable time. And, in that it has been served in the cheaper way, there is, so far, a ground of satisfaction. Only do not let us think that, as a piece of work, it is what it really is not. With supply of adequate means, very respectable work, to state it quietly, has been done by the English in India. Bombay has no need to be ashamed of being the place that has to receive most strangers on their first arrival. They are not made to lose, on coming ashore, the impression made on them when they steam into the beautiful bay.

If not many fine native buildings, either Hindu or Muhammadan, have been erected in our time in India, this may not mean anything more than that the occasions for erecting such buildings are rare, and the resources that can be devoted to them. But it may also, unfortunately, mean that the will of the person for whom the work is to be done has been exerted neither wisely nor well. Within recent years, the combined wealth and zeal of a prosperous Hindu banker have raised, at Mathra, a temple of no small pretension, which at least shows some capacity in the designer. The additions which some of the native princes have made to the buildings at their capitals have not been altogether unsuccessful, though it must be admitted that they have often allowed taste to be violated by the admission of extraneous art. There are, undoubtedly, evil influences of this kind at work, on many other arts and manufactures in India besides those belonging to building.

We might often be inclined to believe that native building power has gone out in other countries where it might be expected to live. Greece, nurtured by the traditions of the past, and taught by its visible inheritances still preserved to her, has done little in modern times to maintain her ancient reputation—very little, if her royal palace is to be an evidence of what she can do. Parthenons are not built now-a-days. We tried it, to be sure, some years ago, in Edinburgh. The money was only enough to build a dozen big pillars. And there they stand, on their proud and airy eminence. And among them, for many a winter and spring, have whistled the raw east winds from the Firth of Forth, which have long ago chilled down all the fervid enthusiasm for a great national monument in purest Attic art. But with plenty of money it would have been done; and with only a claim to good work, which it is, not to high power or originality. We are not looking for originality in India, any more than elsewhere, but for a right use of the art which has existed in days past. And we may be allowed to disbelieve the death of art in India, though, it must be admitted, many murderous attempts have been made upon it.

We are not fully able to say where the earliest building arts came from, of which we see the illustrations in India. There is nothing to show that any distinctive art of this kind was brought in by the intellectual race which, at a remote age, entered India from the north-west, and gradually extended southwards over their new country. There is reason to believe that they found architecture among the people of the south. In whatever way acquired, the Hindùs have shown a very admirable power of forming a style, and working it with great variety of treatment, and great beauty of detail, though not always equal soundness of construction. No special reference is made by the historians of the Greek invasion to fine buildings in India at that time. But the mention of Taxila as a great and magnificent city, seems to tell of buildings at that place that were of some importance. And now we have there only the ruins or traces of numerous small Buddhist topes; and a few other remains, which are undoubtedly Greek.

Muhammadan architecture, which came in from the West, assumed more graceful forms in India than it had done in Persia. It developed other forms again when it travelled westward, and took root in Spain. Moreover, in India, it adopted, in the time of the Emperor Akbar, and under the influence to some extent of his enlarged and liberal views, Hindu forms of ornament, as well as of construction, in works distinctly Muhammadan, and this in a manner very effective and beautiful. And, similarly, in many parts of India, we find Hindu buildings of recent centuries adopting, with more or less success, Muhammadan forms of constructions, with corresponding ornament. They would appear to have something in common, in their fundamental ideas, which allows of these adaptations without marked fault. It is otherwise when we see Oriental forms trying to adopt Italian features, as at Lucknow, where, in some cases, the mistake is aggravated by the effort to make a good show with inferior means.

The dome and arch, borrowed by some modern Hindu buildings, are foreign to pure Hindu work. The construction was unknown to the earlier Indian builders. A well-known illustration of this is to be seen in the great gateway of the Kutb enclosure at Delhi, built in the earliest Pathan times. The arch-shaped entrance is not an arch, but the form is given by horizontal courses of stones projecting one beyond another, till they meet. It would appear that Hindu workmen, unacquainted with the arch construction, were employed to execute the work to a prescribed arch form. The same thing is to be seen in a covered passage at the ruins of Rânigatt, a Buddhist fortified monastery, a little beyond our Yusufzai frontier, to the west of Torbéla on the Indus, above Attok. Likewise in some old bridges in Orissa. The high pyramidal roofs of Hindu temples in the south of India have a dome-shaped crown, which is not a dome. It is scarcely necessary to say that the large Buddhist *topes*, the large buildings of the beehive shape, now pretty familar from drawings and photographs, are not domes, but are formed on a solid core.

One of the most observable things in connection with the best of the old Hindu buildings and groups of buildings, is the attention that has been paid to choice of site, and the admirable skill with which the choice has been made. We admire the way in which English abbeys and monasteries found out lovely sheltered spots in which to plant themselves, in green and peaceful valleys of our own land. No less happy has been the success of the Hindus in the choice of situations for their

buildings. Temples, in shady glens and on wooded hill sides, have been placed where they have beautiful back-grounds of crag and forest, of rich colour and of varied foliage. Such are numerous Hindu buildings, small and large, in Central India and Southern India, in Rajputana, in Kashmir, and elsewhere.

Hardwár, one of the most noted places of pilgrimage for all India, where so many thousands congregate on the 11th of April of each year, to bathe in the sacred waters of the Ganges at the auspicious hour, is built in a position to satisfy Hindu sentiment and love of beauty together. Here the river issues through the lower hills. And, looking northward, two little gaps in the next higher range show two bright snowy peaks away beyond, and no more. To the eyes of the pilgrims the revered sources of the Ganges and the Jamna are thus opened out, as they flock to the sacred bathing steps, amid the temples of Hardwár.

Again, scarcely could a grander site be found anywhere than that where stands the temple of Marttand in Kashmir. Slightly raised above the elevated plain, it commands a truly magnificent view of the valley of the Jhelam, with its beautiful surrounding of snowy hills. It was no chance thought that fixed upon this spot for the splendid temple of the Sun.

Not less skilful has been the choice of the conspicuous spots on which, in the hill country, little temples and other buildings have been erected. The selection of the top of a hill may be simple enough some times, but it is not every hill-top that has pleased the Hindu temple builders, nor is it always a highest point that is taken. Any one who has made his way up to the temple of Chandi Dévi, on the Ganges, or to Raja Hódi's castle at Khairabad, on the Indus, opposite Attok, or who has climbed the long stairs on stairs that lead to the Takht-i-Suliman at Srinagar, and especially if he has made these ascents on a clear, bright morning at sunrise, knows how well the builders have been guided by an eye that strove to be "satisfied with seeing," whether looking up towards the building, perched upon its airy height, or down from it on the fair and far-spread scene below.

Very many are the positions, well-chosen in like manner, of little shrines on the western hills of the Punjab and Sind, most of these being places which, curiously enough as it may seem, are resorted to with equal veneration by Hindus and Mussulmans. And elsewhere positions have been chosen as happily.

It is noticeable that Buddhist buildings, monasteries, temples, and topes, or relic monuments, are many of them built on the open plain, even in the neighbourhood of better ground, with no reason that is now apparent for the choice of their position. Other buildings of the Buddhists occupy, like those of the Hindus and the Muhammadans, commanding sites which seem to have been carefully selected. Some, at least, of those which stand on what we might be disposed to think chance sites are connected with incidents in the traditional life of Buddha, which may account for the exact position in which they are built. And others, probably, have a similar history.

Truly there is often not much room for selection of building sites in the wide-extended plains which furnish the principal no-feature of so large an amount of Indian scenery. Then in these plains the temple will often place itself in a dark shady grove, or under the shelter of a spreading pípal tree. Or the trees have been planted afterwards, to shelter the temple and its attendants. Again we may see how a fine position on a river bank has been taken advantage of, where a favouring bend of the stream gives a fair view in different directions. Situations of this kind are not without their inconvenience. A big Indian river, and, indeed, a small one too, is sometimes apt to be capricious, self-willed, and strong, and to assert its right to play with its banks in a way that is not good. Benares, Patna, and other places on the Ganges have suffered from this cause. When the British came into possession of the Punjab, the river Rávi was found to have cut away one corner of the large walled enclosure of the Emperor Jahángir's tomb at Shahdara, near Lahore. Protective works that were constructed up-stream succeeded in forming, as desired, a new broad bank, which defends the injured wall against further damage, and keeps the river at a distance. Similar measures have had to be taken in other instances, where buildings near river banks were threatened.

Our building predecessors in India did not meddle much with the large rivers. They had to build some defensive walls and terraces on their banks. Bridges, of course, they did not build across such rivers. Never till railways brought their demand for a continuous running line did the British Government attempt anything more than floating bridges on these rivers in the plains. And when we consider the character of the rivers, and the requirements of a permanent bridge, we have no reason to be surprised that even the wealthy Mughal princes and their engineers did not apply their strength and skill to works of this class, and were content, as their predecessors for many centuries had been, to use boats. The pier foundations of one of our railway bridges were scooped away by the stream, at a depth of 70 feet below the river bed. Another of these rivers, at a place where a railway crossing is being built at this present time, has been known to rise, in exceptional floods, upwards of 90 feet above its low-water level. We can feel, in the face of facts like these, that it was right to let the permanent bridges wait till the days of railroads.

Over swift and rocky rivers in the hill country, which it was necessary to cross by a single span, suspension bridges of hempen ropes or cables made of birch twigs have long been in use. On roads where laden cattle were used, something different was required for crossing the rivers. The kind of bridge called *sanga*, in the northern hills, is a good and useful construction, for which the materials were commonly available. A number of beams, laid side by side, project from each bank of the river, slightly pointing upwards, firmly secured by being built into the bank, and heavily laden at the shore end. Another set of beams is made, in like manner, to project beyond these, and others again till the space left in mid-stream can be crossed by single timbers. It is, in fact, like the overlapping stone construction. On cart roads, where something more is wanted, there are no masonry bridges in large single spans by native builders, such as have now been built in British times. It may be of interest to mention that a few years ago, two brick bridges,

each of a single arch, 140 feet span, were built (by Lieut.-Colonel James Browne, R.E.) over two of the rivers of the Kangra district in the Punjab, on the main line of cart road along that beautiful valley.

In the choice of their materials, we see much to admire in the works of the native builders who have gone before us in India. In the most lively times of Mughal building energy, the free outlay on grand works brought costly stone from long distances, and well has their white marble and red sandstone been turned to account. The most ordinary building materials, being such as the earth supplies, have been the same in all ages. The difference in their use, at different times and places, consists in the choice that is made of the better or the worse, and in the means available, in money or appliances, for conveying what was selected to the place where it was to be used.

When we speak of power to convey what was selected to the place where it was to be used, we observe that in India this power is not often illustrated, as in some other countries, by great buildings constructed of enormous stones. This does not seem to have been one of the favourite ambitions of the builders whose work is now to be found in India. There are, of course, big stones in some buildings, but their bigness is on a different scale from that adopted in other lands, and is not such as to give rise to the admiration which we feel in seeing what has been done elsewhere. There is a big trough at Vizianagar, in Southern India, cut out of a single stone between 30 and 40 feet in length, but it is probable that it has never been moved from the place where it was made. There is a temple in Kashmir which is built of five stones, one for each of the four corner piers, with its portion of roof, and the fifth a square pointed piece, which crowns it. But the whole building is not a quarter of the size of one of the big stones in the terrace wall of the temple at Baalbek.

The masonry of the outer enclosure walls and basements of certain Buddhist works in North-Western India, perhaps the oldest masonry now standing in that part of the country, is of a peculiar kind of effective roughness. It is without mortar. The large stones are unsquared. They have a tolerably flat face, but there has been no endeavour to make them fit each other. Between the stones are irregular gaps of varying width, which are filled in with pieces of slaty rock, all laid flat, and firmly driven home into these wide joints. There are many specimens of this kind of work in the Buddhist tract of the Punjab frontier districts.

There are likewise in India stone circles of upright blocks, like those well known in England and other countries. In one of these circles near the village of Asota, in Yusufzai, north east of Peshâwar, about 50 ft. in diameter, the stones have been roughly hewn on two sides. Their greatest thickness is about 2 ft., and the greatest height of any now standing is between 11 ft. and 12 ft.

It is remarkable how little (speaking generally) even the oldest buildings in India have suffered from exposure; and this exposure is sometimes of a very trying kind. The buildings bear testimony to the good choice that has been made of the stones used in them. A dark and hard blue limestone has been a favourite material with the Hindús. It receives fine sculpture, and retains sharp, well-defined edges. Much of the Buddhist sculptured work in the north-west of India, where sculpture is very abundant, is on hard clay slate. The sculpture on these buildings is mostly on the interior faces. The Jain temples at Dilwara, on Mount Abû, profusely and beautifully carved inside, are of white marble. Outside, these buildings are of studied plainness, not as the Hindu buildings, great and small, in all parts of India, which carry much ornamentation outside. The largest of these—the magnificent temples of Tanjore, Trichinopoli, Tinnevelly, Madura, and other places in the south, of Nassik in the west, and of Orissa in the East—being covered throughout with elaborate carved ornament and sculpture. On the hills of the Salt Range in the Punjab (hills containing the great mines of rock-salt) are Hindu temples of a grey limestone, naturally of a somewhat honey-combed texture, which has suffered further from the weather.

In the great imperial cities of the Mughals white marble and red sandstone have been largely used together, and with excellent effect. The marble is polished, and well withstands the weather. But though it suffers little from the weather, there is another kind of injury, very subtle and troublesome, to which it is exposed. However carefully and closely the stones have been laid, yet, into the joints between them, on domes and terrace roofs, on cornices and parapets, the seeds of shrubs and trees will find their way, and there begin to grow and thrust their roots beneath. The pípal tree is particularly insidious in this kind of attack on unwatched stone-work, and if allowed to stay, as we see it has been sometimes, it will slowly, but strongly, dislodge the stones, and, if there is water near the foot of the building, will push its long roots through the wall, and down towards the moisture that it seeks.

In the Muhammadan buildings of Akbar's and later reigns—the seventeenth century and the latter half of the sixteenth—the red sandstone is very largely used. There are buildings of earlier date, now six and seven centuries old, in which this stone, frequently bearing Arabic inscriptions in raised letters, is still sharp-edged and fresh. It contrasts very favourably in this respect with many buildings in England sadly defaced by weathering of the sandstone. Oxford, perhaps, looks more venerable where the edges of the stone are worn and rounded, and the form of the mouldings lost; but it would have been better if this had not happened. There are buildings in this country of a sandstone much resembling in colour and general appearance that of the Mughal works in Northern India, but very different in durability. The exposed masonry of the Church of St. Michael, at Coventry, is seriously worn away, and seems to be crumbling continuously now. In past days, endeavour has been made to hold together with iron straps parts that were in danger of separating, and in some of these places little more than the iron strap now remains.

In the Indian buildings in which both white marble and red sandstone are used, the contrast of colour is sometimes given by the use of the different materials for different parts of the building, sometimes by using them together, in alternate bands, or otherwise combined. Colour is likewise shown in the Muhammadan buildings by inlaid work in the piers of the arcades, the spandrils of the arches, and other parts, and by lines of black

marble inlaid in the white. The inlaid work is executed on a large scale in some buildings. The stones chiefly used are blood-stone, carnelian, and agates. The inlaid work, besides that on the borders of panels and elsewhere in geometric figures, is chiefly representation of flowers in conventional style, and often with much freedom from the rigid symmetry which prevails in most Oriental designs. Inscriptions in the Persian or Arabic characters are either inlaid or carved in raised letters, not engraved like our inscriptions. In the interior of the great reception halls of imperial buildings, and the more ornate private apartments, gilding also was much used. But some of the most beautiful of these Muhammadan buildings, are those in which there is least colour or applied decoration of any kind, so elegant are the forms and so just the proportions of the several parts, so refined the mouldings, and so true the execution. One other kind of ornamental work of much beauty is especially to be observed in these buildings, the stone screen-work of open tracery—large thin slabs of marble or sandstone, pierced with geometric figures of great variety. Very good specimens of this kind of work are to be seen in the Indian section of the South Kensington Museum.

The comparatively small variety of colour thinly applied on the outside of the Táj Mahal at Agra—the Indian building perhaps best known in England—is the cause of its having frequently been felt, at first sight, to be heavy. It is not really unrelieved by variety. Besides some inlaid coloured work, it has straight lines of black marble inlaid, black zig-zag lines on the thin engaged pillars at the corners, inlaid ornament following the outline of the parapets, and encircling the neck of the dome, and inlaid inscriptions in large letters. But so immense is the mass of white marble, that the relief thus afforded is comparatively small. A little study of the building reconciles the spectator to this massiveness, and only leaves him full of wonder and delight with the beauty as well as grandeur of the building. Its surroundings are on a scale of corresponding magnificence. The great square enclosure, with its splendid gateway, and the minarets at the corners; the straight-lined garden and its broad masonry channels, with shallow stream of water and rows of fountains in the middle; the sombre lines of tall dark cypresses, with trees of more varied foliage and colour throughout the garden;—it is with these things about it, and a sense of great stillness and solemnity over the whole, that we look at this magnificent marble tomb. And we feel how large a measure of respect and gratitude is due to the men who did all this, to those who purposed and devised a monument on this scale of grandeur, and those who executed it in a manner worthy of the conception. Have not we reason to be glad that the wealth of building power in those days threw itself into forts and palaces, mosques and tombs, pleasure gardens for princes, and serais for travellers? What should we not have lost if Shah Jahán, for instance, had been a prince of smaller and more modest aims, and had bestowed the best efforts of his architects on jails and court-houses, town halls and barracks, hospitals and schools? Their time has come. But it is better for art, that Shah Jahán had his turn at something else. The world has gained.

If defect of colour enhances the noble massiveness of the *Táj*, we feel this to be in agreement with the nature and purpose of the building. The use of colour on Mughal buildings was well understood and very general. In the beautiful and wonderful city at the head of the Adriatic, which so many travellers to and from India have now-a-days an opportunity of seeing, we find a large amount of colouring of buildings, most of it very Oriental in character. But India has nothing to show of exactly the same kind. Buildings of brick, in India, if not faced with stone, were thickly plastered, and the colouring was given by figured designs, not whole surfaces of colour, or by a facing of glazed work, which is of two kinds, on pottery and on plaster.

The use of glazed tiles and glazed plaster seems in India to be most frequent in the western frontier provinces of Sind and the Punjab. But there are many good specimens at Gwalior, Delhi, and elsewhere, of buildings thus coloured. The work goes by the general name of *Káshí*. Glazed tiles are used when a large surface is to be uniformly coloured. Patterns also of different colours are given on single tiles. The glazing on plaster is used for coloured devices, made up of separate small pieces, of the different colours. And these are laid on and cemented on the surface of the building. The plaster, which is made of lime and sand, receives first a very thin coating of glass containing lead, which both gives a fair smooth surface for the coloured glazing that is to be afterwards applied, and enables it to adhere. Both these arts seem to have been imported from Persia. The earliest specimens of glazed tile work known are at Mashad and Tabríz. The name Green Dome (*Sabz Gumbaz*) which is given to a conspicuous building at Mashhad, of which the city is proud, is also borne by a tomb at Lahore, of which the green covering of the dome is in good preservation. Another at Lahore is similarly called Blue Dome (*Lila Gumbaz.*) The cities of Multan in the Punjab, and Tatta, and Hyderabad in Sind, and others, have good specimens of this kind of work, as well as of the plaster *Káshí* work used for wall decorations and inscriptions. Lahore has many of great excellence and beauty, the most complete is the mosque of Wazir Khan, in the heart of the city. The figured tile work is now carried on in Sind, at Tatta, on the Indus, and at Hala, 30 miles north of Hyderabad. The Masjid, built by Shah Jahàn, at Tatta, has had the deficient tile work lately restored. At this place there is no glazed work of the other kind, that is, on inlaid pieces of plaster.

Indian brick-work, except in wells, is rarely seen, for it is always covered, or meant to be covered, in one of these ways. Its quality is excellent, though its appearance is coarse, as it was not meant to be seen. Well-burnt bricks are united by well made but rough mortar, the mortar courses being of great thickness, often much thicker than the bricks, giving the work the appearance almost of a concrete wall with thin bands of red brick. It is indeed a concrete. A similar material is used for terraced floors and roofs. And there are places where, the wood and tiles on which it was laid having decayed and fallen away, the terrace covering has remained, spanning the gap, as a single block of artificial stone or concrete bridge.

In stone buildings in various parts of the hill countries of India, the insertion of horizontal beams at intervals in the masonry, which is a common constructive arrangement, gives a pleasing variety to the outer face of the work, like the use of stone of different colours. The practice is similar to the use of bonding courses of red brickwork, which we see in Roman walls of stone masonry in Britain. This was well shown in the old wall lately discovered in extending the railway buildings in the neighbourhood of the Fenchurch-street Station. The bright red bands were of tiles or bricks of large size, of which there were three courses in each horizontal band. Similar bonding brickwork of bright colour is to be seen in a massive Roman wall at Leicester; of which English builders have taken advantage in a very practical way, by using part of the materials, both brick and stone, for the adjoining church of St. Nicholas. In the church the construction is repeated, stone masonry with courses of brick at intervals. The cathedral of Carlisle has in like manner helped itself to stone from a neighbouring Roman wall.

In these cases, as in many others, perhaps no great harm was done, as the walls were plain and uniform masses of solid masonry, interesting chiefly on account of their history and their construction, and having plenty of the work still left to satisfy this interest. But the practice is a dangerous one. It has been often followed, in all countries, and has sometimes not been quite so harmless. We cannot tell now what we have lost at old Delhi. Bernier says, Shah Jahan's new city, which was being built when he was there, was conveniently near the old one, which supplied quantities of building material ready for use. Very likely the honest intention in the first place was to take only the stones from absolute ruins. But we know how difficult it is to get any rule of this kind rigidly adhered to, and to prevent the despoiling of buildings which, if in a sense ruins, are yet ruins to be carefully and tenderly preserved. And these Mughals, though they showed admirable taste in their own works, felt no obligation to spare Hindú buildings on account of their beauty, even if they always respected those of the Pathans. Zealous Muhammadans, from time to time, have reckoned it no less praiseworthy because it was convenient, to destroy temples and other works of their idolatrous predecessors, though they did not often use the materials again on the spot in so pretty a piece of reconstruction as the colonnade at the Kutb, near Delhi. Muhammadan buildings, again, have been subjected to the same treatment. Ranjít Singh's marble *báradari*, or summer-house, in the palace gardens at Lahore, is certainly a very graceful building as it is, though rather too large for the enclosure in which it stands. But we cannot, therefore, excuse his robbing for this purpose the tomb of Jahangir at Shahdara.

Of a too indiscriminate freedom in using materials of old buildings, even English engineers in India have sometimes been accused. There are stories (Mr. Fergusson knows some of them) of English officers having turned to ignoble uses fragments which were of real worth and interest, and which, in time of pressing need, were appreciated only for their immediate usefulness. I am not prepared to say that such things have not been done, though I do not myself know of any instances. There are in many places abundant supplies of old materials, particularly old bricks, which, being taken from absolute ruins or worthless buildings of the plainest kind, or dug out from the foundations of old towns and villages, can be freely used for new works. And this use of such materials need not give cause of unpleasantness to the tenderest conscience, or call forth remonstrance from the most protective antiquarian. But it has not always been easy to draw the line, or make a vigorous contractor keep to it.

Besides defence of good buildings against active spoliation, protection against natural decay is needed. Whatever have been the shortcomings of the British Government, and the offences of British officers in India, in times past, with regard to the care and preservation of old buildings, it is not now to be said that the matter is neglected. The works which it is desirable to guard and preserve are in such number and of such size, that not all can be done at once that is needed. But arrangements with this view have, for some years past, been made more systematic, and they are now being brought more fully under uniform management. Everywhere attention is now given to the subject, and local measures are taken to stay the progress of decay. Restoration is not attempted, except in some very special cases, but endeavour is made to preserve from further injury what time and the hand of man has spared, of buildings that we desire to save on account of their architectural or historical interest.

India is generally believed to be a country which has been very stationary in certain respects, many arts being practised in the same manner now as long ages ago. In regard to building arts, this is probably not more true of India than of other countries. Until the introduction of what we commonly understand by machinery, and when all ordinary building work was done for the most part with hand tools, as very many things are done still, these common operations have been essentially the same everywhere. They may vary in some particulars, as for instance, in India and some other countries, in the common use of the feet for some parts of what we are accustomed to call manual labour, and the practice of sitting on the ground for some kinds of work which European artisans do standing. But, in the main, we have reason to believe the operations and the implements to have been much the same for long ages past, in all countries alike which have come to need any such arts. Sculptures and pictures tell us something of modes of working in ancient Egypt and Assyria. Written accounts tell us how, more than 2,500 years ago, in the land between these two, the smith with the tongs used to work in the coals, and fashion the hot iron with hammers, wielded with the strength of his arm; how the carpenter stretched out his rule on the timber, marking it with a line, then fitting it with planes, and applying the compasses; which briefly, and not inaptly describes the mode in which men of the same crafts work in all lands in the present day. The same may be said, no doubt, of the stone-hewers who, three centuries earlier, came from Tyre to build the king's house at Jerusalem. It is when we come to see the scale on which some of

this stone-hewing work was done, without such mechanical helps as we have now, that we admire the resolute and persistent way in which immense labour, aided only by simple and primitive appliances, was used to overcome all difficulties in carrying out a settled purpose. The labour bestowed upon building works in India has not been of this kind. We see that it was of a kind demanding other qualities as high, always more under the direction of artistic feeling than of ambition to exert enormous power.

About these old Indian buildings, sometimes a good deal, and sometimes not much, is to be learned from the people you find about them. They sometimes know nothing that you want to know. Others will tell you a great deal which you had better not put down as quite correct because you got it on the spot. But you may often learn much from a humble informant that will help you to an understanding of the thing you are looking at. A deal of intelligence and knowledge is often to be found under the familiar orange-brown costume, or the more simple garment of white ashes. We can tolerate, for a while, what is not attractive, when we find how much there is along with it that is better than it looks. And if we have learned something about the building that has engaged our attention, we are also the better, and so is somebody else, for our little talk. It has drawn out something like sympathy in regard to an object that has at least some common interest for the Indian fakir and the English Christian. We have gained more than information from the opportunity the old building gave us of a chat with an unenlightened, perhaps, but not worthless, fellow man. The sympathy, if it is small and imperfect, quickens the desire for sympathies that shall be fuller and better.

There are few people who have spent years in India, and have seen a good number of the buildings of the people that were there before us, who have not brought away with them a strong and pleasing conviction that these old builders were men who had a true knowledge of what was constructively good, and a true sense of what was artistically beautiful. It is good that English folks who go to India, and who care for such things, should know how much there is in the buildings of that country that will have an interest for them. This is only one, however, of the very many classes of objects which India displays to us and asks us to look at. I would not present it even as one of the most important and most interesting of the many objects of interest and importance. I would desire rather to show that there is much else, and that no one need want in India local objects of interest to engage some portion of his time and attention. It is well, when the hands are full to satisfaction of useful work, to find some things around us, apart from that work, whatever it is, which will pleasantly help to fill up some of the leisure hours, and thereby lighten the hours of labour—always with the aid of recreations of some sort, which are quite as needful in India as elsewhere.

What the particular classes of objects are, to which any one is to turn his attention, depends on tastes and opportunities. It can seldom be that opportunities will not yield something. To one, the earth's own products, in the garden and the field, on the hill and the plain, supply unfailing sources of study and enjoyment. To another, the investigation of the earth itself. To another, the field sports of India afford the means of seeing and knowing many more things, besides the creatures which are the objects of the chase. One in the languages and literature of India finds ample material for profitable research; another in the arts and manufactures; another in the history and antiquities; another in free intercourse with the people and the study of their local dialects, their personal and social customs, their traditions and stories, their proverbs, and their songs. In all these ways one learns to know also something of the thoughts of the people, their feelings, and their wants; and, let me add here, always in so doing, learns to think more kindly of them. This, and much more there is, in the records of the past, the life of the present, and the needs of the future, to supply matter of deepest interest to every English sojourner in India.

It is needful sometimes to notice this, for there are some people who cannot believe there is anything in India in which they could manage to get up an interest, or which could help to reconcile them to the country. They make up their minds there is nothing there for them to like or care for, and a great deal to object to. And there are things to object to. An English traveller of the early part of the seventeenth century, the chaplain of Sir Thomas Roe's mission from James I. to the Emperor Jahângir, devotes a chapter of his book to what he calls the "discommodities, inconveniences, and annoyances, that are to be found or met withal in this empire." And he goes on to tell of them in detail. There have been many improvements since Edward Terry was in India, but "discommodities" and "inconveniences" there are still. Snakes and scorpions have not been abolished, though, indeed, you do not see them so often as some people have supposed; there are still mosquitos and sandflies, as well as other small insects; there are musk rats and white ants; there are dreary wastes and dirty dust-storms. And it is sometimes very warm in India. Yet, somehow or other, with all these things and many more, it is not a bad country after all, and, as Terry himself properly adds at end of his chapter, there are also "commodities and contentments to be found in those parts."

Much of what we now find to delight us has been created since his time. Akbar's grand administration was then over. Shah Jahán's magnificence was yet to come. The two centuries that have gone by since his day, have made a great difference to us, and to the people of India, and have greatly helped forward the knowledge of many of the things of interest I have referred to, which present themselves to us in the present day. I do not press the claims of any one above another. Each has its interest, and will get people to care for it. Whatever the line each person may take, who cares to give attention to his surroundings in India, all I am concerned here to say is,—don't forget sometimes to look at the old buildings.

DISCUSSION.

Mr. B. Haughton, C.E., said that on a previous occasion he had mentioned in that room the Taj Mahal

as being the work of Indian architects, and brought it forward as an instance of the extraordinary architectural capacities of the people of India, whereupon he was contradicted, and told that the Taj was built by Italian architects. He should be obliged if General Maclagan would give his opinion on this point. He had since consulted the Encyclopædia of Larousse, in the British Museum, in which it was stated that the Taj Mahal was a marvel of Indian art, that it was built by Shah Jehan, in honour of his wife; that it consisted principally of white marble, was commenced in 1631, occupied 20,000 workmen, that the marble was brought a distance of 200 or 300 miles, and that the expense was 80 million francs; it was also stated that some persons pretended that a Frenchman, known in India as "the marvel of the age," laid claim to the paternity of this *chef-d'œuvre*, which had not a rival in the world. He had been much struck with General Maclagan's description of the thin brickwork, with a thick layer of mortar between, so different to the mode of building in Egypt. He had tried in vain to insert the blade of a penknife in the joints of masonry in the pyramid of Cheops. He had roughly calculated that the large stone in the ruins of Baalbeck spoken of, must have weighed about 800 tons. They were accustomed to large stones in Egyptian buildings, and other ancient ruins, as, for instance, those at Tadmor. It was very satisfactory to hear that the specimens which had been produced were not taken from actual buildings; but, unfortunately, a different spirit sometimes prevailed, for he had seen large pieces knocked off the Cleopatra's Needle now at Alexandria, with a geological hammer.

General Maclagan said it had been ascribed to European architects, and the question had been much discussed, but opinions were most in favour of the conclusion that the Taj Mahal was a purely Oriental construction. He should have a very high opinion of the French architect who had designed and constructed such a building. With regard to the style of the masonry, he observed that stonework in India was quite as fine as that in Egypt; it was only brickwork that was laid with such thickness of mortar as he had mentioned. The habit of Englishmen and others of bringing away specimens of anything remarkable or interesting was very general, and he could quite believe what had been said about pieces being chipped off Cleopatra's Needle, for where it lay many years, half buried in the sand, it presented tempting facilities to visitors of this class. Some travellers left their mark without taking anything away, and at Baalbeck, on the building containing the magnificent stones he had mentioned, he had seen names painted in letters a foot or fifteen inches high.

Mr. Thornton C.B., said he thought he could clear up the question about the architecture of the Taj. In the itinerary of Manrique, a Spanish monk, who lived some time in India, in the time of the Shah Jehan, it was mentioned as then being built under the supervision of an Italian architect, named Geromino Veroneo. He stated that Geromino was asked by the Emperor to make an estimate for the construction of Taj, and accordingly, with the help of native architects, he made an estimate, and gave the cost at 3 lacs. The Emperor said that would never do, he could not have a building of that cheap description, whereupon Geromino retired, and after a time produced an amended estimate of 19 lacs, which was eventually accepted. This Geromino Veroneo was afterwards sent to Lahore, probably to superintend some works there, and there he died. With reference to the art called Kashí—the coloured tiles, which formed so prominent a feature in so many buildings at Lahore—there is a tradition there that it was introduced by the Moguls from China, originally through the influence of one of Timour's wives, who was Chinese. The word "Kashí," he was told by those conversant with the subject, was derived from an Arabic word, signifying a porcelain cup.

Mr. W. Simpson said that the last speaker had given so far an explanation about the building of the Taj, that there were foreign architects who had been engaged on the work; but he believed when Manrique went to Agra, Veroneo was dead, and the work had been then taken up by another Italian, named Castro. Full information on these points would be found in a small article, by Judge Keene, in the 11th volume, new series, of the "Asiatic Researches."

Mr. Thornton said he had supplied Mr. Keene with the information.

Mr. W. Simpson said it had been generally understood that a Frenchman, Austin de Bordeaux, had been connected with the Taj, but he supposed that this work of Manrique had settled the point as to the existence of European art on that structure. He (Mr. Simpson) visited the Taj in 1860; at that time the question had been mooted, but he had no need to look for historical information as to whether it was the work of a foreign architect, for foreign art was written on the face of it as palpably as could be. He had no doubt when he saw the ornaments, the inlaid work in the spandrils, as well as in other parts of the building, that foreign artists had been at work upon it. It was at that time, at the building of the Taj, that this Florentine style of ornament came to India, and it had remained there ever since. The design of the Taj was undoubtedly similar to other designs of Mahommedan tombs in India. He could not give to the Taj the high praise which some did; it seemed to him to belong to the decadence of Mahommedan architecture, and from it you came down to the stage which at present could be seen in Lucknow, where it became simply stucco and plaster, and ceased to be worthy of the name of architecture. The Taj was not to be compared for real art with the older work about Delhi. He considered that Indian Mahommedan architecture ceased almost with Akbhar; it was at this time that the Mahommedan had combined in a most beautiful manner Hindoo forms with his own, and then came in the foreign European style, which never amalgamated with the Indian, and the Indian art descended to the low state it was now in at Lucknow. He had listened with very great pleasure indeed to General Maclagan's paper, especially as he had been to nearly all the places he had mentioned. He had ferried across the river on a morning such as had been described, and had sketched the picturesque boats. He had crossed the Wangtoo Bridge on the Sutlej, which was similiar to the one described by General Maclagan, and had also crossed bridges of rope, and had drawn the peculiar arch in the old Musjid at Delhi, to which reference had been made. To know the building arts of India, one must have travelled in India, which he had had the pleasure of doing, so as to realise the amount of building which had been done in that country in the past. At Delhi, there were about 40 square miles of ruins. When he wandered about sketching them, he thought the Mahommedans were really the great men of India; but he went the next cold season into Rajpootana, and came upon the old city of Chitoregurh, the ancient capital of Mewar, where there were ruins about three miles long, and a mile wide, of the old city which the Rajpoots left when it was sacked by the Mahommedans. So it had remained ever since, and it was certainly a most wonderful place, and since seeing it, he doubted whether Mahommedans were the greatest of Indian architects. They were certainly great, and the ruined tombs of Delhi were undoubtedly the most beautiful of their remains. There were many other places where remains of buildings were found. On the site of Kanouj, it was said you could not dig for twenty miles around it without coming upon bricks, which would give some idea of the extent of the ancient towns. In addition to

what stood above ground, the Archæological Survey were now unearthing some of the old cities. He might say, in conclusion, that there was no country in Europe, or any other part of the world, to compare with India for buildings and building remains.

Mr. Haughton thought that, in their enthusiasm for Indian art, they must not be too hard on the present rulers of India for not producing works of a similar kind. If they took the cost of the Taj at three millions sterling, and compared that with the amount of money we had spent—in this more utilitarian age—for railways, we had very fair results to show. We had spent about 120 millions sterling on railways alone in India, which would have built 40 Tajs; and, besides that, there were many other works of utility, such as irrigation, &c., which had been constructed.

Sir Joseph Fayrer had listened with very great pleasure to the paper, as it revived the charming reminiscences of his 22 years' residence in India, and brought back vividly many of the most distinct features of the country. Many people, talking about India, said there was nothing to be seen there, and he was very glad that General Maclagan had read this paper, which showed the fallacy of such a statement. When one thought of the grand ruins of Old Delhi and the Kutub, the magnificent ruins at Agra, part of which there were now happily preserved in the fort; or the old city of Futtipore Sikri, where there were certainly some very large blocks of red sandstone; or the beautiful carved screens to be seen in many places, mostly of the time of Akbar, it was absurd to say there was nothing to be seen in India. One thing had impressed him very much when he left the North-West Provinces and went to Lucknow, it was that the art of constructive building must have ceased with the Mohammedan Empire. The buildings at Lucknow were, for the most part, miserable structures in comparison, consisting of stucco, plaster, and brickwork. With regard to the Taj Mahal, he thought he had seen somewhere that it was constructed by native builders, although an Italian architect designed it; but he believed the truth was that the decorative work, the inlaying, carving, &c., was Italian, whilst the main design of the building was Oriental.

Colonel Keatinge, V.C., C.S.I., wished to make one remark in answer to an observation made by General Maclagan, and which had also been referred to by another gentleman, that since the English rule in India the natives had constructed no important new buildings, and this undoubted fact was often put forward as a reproach to the English Government. He thought, however, that this was not a fair charge to make. Before the English rule was established in India, it was impossible for anyone above the rank of a common cultivator of the soil to live in an Indian village; life was not secure enough, and the people, by the misrule of the country, were forced into the great cities, and when they congregated there it was natural that they should wish to distinguish themselves by building temples or mosques, or tombs. But when English rule was established, in proportion to the prosperity and safety of the people, they left the cities and went into the country, to occupy themselves in trade and agriculture, in a way they had not been able to do for two or three centuries before. He had on two occasions seen cities become nearly depopulated, but he was perfectly certain that it was caused by the prosperity of the country at large.

General Maclagan, in reply, said there was no doubt that what Colonel Keatinge had said was, to a great extent, true. He had said in the paper that, except in the native States the occasion for erecting grand buildings were rare, and also the means available to be bestowed upon them. There were some beautiful buildings, as Sir Joseph Fayrer had observed, at Fattehpúr Sikri, built with large stones, and there were large stones in many buildings in India; but their size was on a scale very different from those at Baalbek, the great arch in Jerusalem, and other places. He agreed very much with what Mr. Simpson had said with regard to the change in the style of architecture after Akbar's time. The builders of his day adopted Hindoo forms with remarkable success. There were some specimens of pillars, corbels, brackets, &c., of Akbar's time in the Indian branch of the South Kensington Museum, which were of great beauty, and would show exactly what Mr. Simpson referred to. There was a certain massiveness about the architecture of that time, which he quite agreed you did not find afterwards. Still, the beauty of such a building of later days as Jama Masjid, at Delhi, the elegance of form, and proportion of the domes, the minarets, and cupolas, and other parts, was undeniable. He had with him some photos, in which the beauty of the details of buildings mentioned by Mr. Simpson was remarkably shown. Mr. Simpson had observed these things probably with more attention than any gentleman in the room, and the results of his observations were of much value.

The Chairman then proposed a vote of thanks to General Maclagan for his admirable paper, which was carried unanimously.

NINETEENTH ORDINARY MEETING.

Wednesday, May 4th, 1881; Lord ALFRED S. CHURCHILL, in the chair.

The following candidates were proposed for election as members of the Society:—

Bonar, Lionel Ninian, 75½, Old Broad-street, E.C.
Butler, Lieut.-Col. Henry Thomas, 66, Prince's-gate, S.W.
Campbell-Walker, Capt. Arthur, Ashley Warren, Walton-on-Thames.
Gibbs, Sir B. T. Brandreth, 13, Pelham-crescent, South Kensington, S.W.
Hudleston, Wilfrid H., M.A., F.C.S., F.G.S., 23, Cheyne-walk, Chelsea, S.W.
Lee, Charles John, Fairlight-villa, Sydenham-road, Croydon.
Nesbit, A. Anthony, F.C.S., 38, Gracechurch-street, E.C.
Nevill, Lady Dorothy, 45, Charles-street, Berkeley-square, W.
Stirrat, Robert B., 7, Grey-street, Newcastle-on-Tyne.
Walkinshaw, William, Hartley-grange, Winchfield, Hants.

The following candidates were balloted for, and duly elected members of the Society:—

Beattie, William, London and South Western Railway Works, Nine-elms, S.W.
Cockburn, James, 11, Heathcote-street, Mecklenburgh-square, W.C.
Crossley, John Thomas, Q.C., 91, Cheyne-walk, S.W.; 4, New-square, W.C.; and Junior Athenæum Club, S.W.
Gibson, Joseph F., Clovelly, Woodchurch-road, West Hampstead, N.W.
Goodwin, Thomas, 12, Southwark-street, S.E.
Law, James, 544, Oxford-street, W.
Lovett, William John, Carver-street Works, Birmingham.
Lyell, Francis Horner, F.R.G.S., Nettlestone, Widmore, Bickley, Kent.

MacGregor, Alexander, M.A., 6, Charles-street, Berkeley-square, W.
Powell, Frederick, F.R.G.S., Bakewell, Derbyshire.
Pupikofer, Oscar, 28, Finsbury-square, E.C.
Stubbs, William Henry, 3, Winton-square, Stoke-on-Trent.

The paper read was—

BUYING AND SELLING: ITS NATURE AND ITS TOOLS.

By Professor Bonamy Price, M.A.

Buying and selling are matters so plain, that it almost seems idle to ask what they are. They are things done by everybody every day. Yet in the practical world, the most familiar things, though they may have the greatest importance for human life, are often the least understood. They are the very region where confusion and mischief dwell.

Look, for instance, at the different senses given to the word money, and the power which the ideas attached to it exercise over human life. Yet how many can answer—What is money? and how is it that it buys?

First of all, let us inquire whence came buying and selling? How is it that they are so universal amongst human beings? They spring from the most peculiar and characteristic feature, the greatest power of civilised life, division of employments. I will make this for you, if you will make that for me, is the basis of civilised existence, is the root of all progress. Hence it is that exchange is the very core of political economy. Division of employments enables each man and people to perform that work for which each of them has a special aptitude. It creates skill, developes machinery, obtains larger and better results from the same labour, then reduces the cost at which they are made, and consequently vastly diminishes price. By dividing out the work to be done amongst each other, mankind acquires more wealth and finer quality at the end of the day's work.

The first consequence of division of employments was barter. But a most embarrassing difficulty immediately presented itself. How could the men who mutually wanted each other's goods be brought together for exchanging? On a large scale, as society developed itself, and employments grew in number and distance, that was impossible. How could a farmer have found a tailor who would give him a coat, or a shoemaker who would give him boots, in exchange for a calf or a sheep? What could the tailor have done with the calf? Exchange would have stuck fast, and only a petty village life would have been possible. The difficulty was solved, and civilisation won, by Indians. They invented money, a money made of skins. The perplexity vanished. The career of trade was opened for the human race. The mighty machinery of division of employments was established.

The savages invented a true money. They consented (to use the language of city men) to buy and sell with skins, and these skins tell us what money is, and how it works. The skins were commodious pieces of wealth, useful, and consequently valuable. They cost labour to produce, and that gave them worth as against other articles. The trouble of the day's chase, the food it cost, gave value to the skins. The skins would not be procured, much less given away, without compensation; in economical language, they possessed value—value in a market, value in exchange. The instinct of the Indians made them willing to take skins as money. Each man knew that all others would take them in turn as money. The hunter was always sure of getting food in exchange for them. Every man who took them could, if he pleased—just as the gold of a sovereign—at any moment make them cease to be money, and take them as things for use. The skins reveal the fundamental truth, so generally unperceived, of the nature and the working of money. It is a tool, an instrument, a machine—absolutely nothing else. There is no fact about money of vaster importance to grasp than this, simple and obvious though it seems to be. These skins were not taken to be worn; they were intended to circulate about from man to man, for working as tools, with this peculiarity, that they could do work only once for each man. That is what is meant by circulating. This is precisely what a sovereign is and does. It is a pure tool, of no other use whatever, so long as it remains a sovereign, and is not melted. If only bankers and merchants would suffer their minds to be penetrated with this truth, that gold, coined as money, is an idle, useless thing, unless it does work as currency. The skins wore out in the handling; so does a sovereign, but when it is gone it has performed services well worth the wearing out. The sovereign does nothing else in the world but pass from hand to hand, precisely as a spade or a locomotive are worthless things, unless they perform the work for which they were invented.

Now we can answer the great question which the city finds so hard to answer—How is it that a sovereign buys a hat? You cannot pay too great attention to the answer, perfectly simple though it be. It buys because it costs as much labour and expense of carriage to bring that small piece of metal from an Australian mine as it costs to get the materials for a hat, and to manufacture them into a hat. The whole mystery of money vanishes at once. There is no better money than a sovereign. The gold buys by means of its cost of production; certainly not, as so many have said, by virtue of its stamp as a coin. The stamp only shows that it is made of good metal of the right weight. The hatter sells for a sovereign, because, in the language of Aristotle, he knows it to be a useful commodity. He gives away the hat for a piece of metal, into which he can convert the sovereign, if he pleases, precisely as the Indian might take the skin he bought into wearing. He relies on the worth of the metal, that gives him the assurance, the all-important assurance, that other sellers will give him goods of the same value as his hat, that they will give him articles worth the metal of the sovereign, that is, worth his hat. It is the gold which buys; the word money is not needed to explain the fact. That this is so, is proved by the daily fact that nations pay their trade balances to each other in bullion; they are willing to be paid with the amount of uncoined metal contained in the money due.

But though skins are real money, and possess the true nature and mode of working that tool, still they are not good money. They are cumbrous,

wear out fast, are of uncertain supply and value. Gold is the best material yet known to make this tool of. It is hard, pleasant to handle, very light for its value, divisible into parts, can be restored back into a commodity easily, and, above all, has the greatest of qualities for serving as money—steadiness of value. For the innumerable debts and investments expressed in money which characterise modern life, the payment of the same value, as was estimated at the time when the debt was made, is of the most supreme importance. It has been held by many that gold itself has become cheaper, but it has never been definitely proved. Time fails for discussing this most complicated matter.

We now can see clearly that an act of buying is an act of barter, the substitution of double for single barter. The sovereign is first bartered for a hat, and is re-bartered by the hatter for an umbrella. They have been exchanged by the action of the tool money. Further, money furnishes the means of measuring the values of commodities against each other. All have their price in money. Thus the value of a £30 gun is found to be 30 times greater than the value of a hat. The convenience of such measurement is enormous.

But attention must be drawn here to a fact of great significance; good money works by the cost of production of the metal it is composed of; but the prices of many articles are determined by other forces besides cost of production. That must always be given; but a power often comes into play which varies price, expressed by the word value in the sense derived from the verb, I value. It is a feeling, and is the greatest force in all political economy. It denotes the esteem which is felt for an object, the amount of caring for it, the power which determines how great is the effort which a buyer is ready to make to acquire it, how large the compensation which must be given to a seller for the sacrifice of parting with it. This feeling is attached to every article bought, but to many it adds a price far higher than the cost of production. A Raffaelle picture, for instance, an old marble, a distinguished autograph, and the like, sell for immense prices, dependent on feeling more or less fanciful. They would make excessively bad money. A buyer who had given £10,000 for a Michael Angelo, would have no security that he could change it afterwards for anything like that value. Ordinary cost of production is a determinate quantity, and is the same for all. It thus can increase all value, whether dependent on feeling or other.

The cardinal fact, that money—a sovereign—is a tool, and a tool only, is full of instruction. In the first place, it kills off the mercantile theory that traders love to hear, that exports ought to exceed imports. A more foolish idea cannot be imagined. The fact denotes that the goods of the traders are being sold, and there they stop. If only they can get hold of the money, they ask no more questions; they feel that they can always know what to do with it; they can buy what they like. But is the country the richer for this increase of coin? Could these good people have bought less, if they had been paid with imports instead of money? Is a farmer the richer, supposing him to have as many carts as he wants, if he is paid for his wheat in carts? Oh, but a farmer could not get rid of his excess of carts easily; there is no trouble in buying with money, if only the money is in hand. But what becomes of the money thus acquired by an excess of exports? The answer to this question depends on another. How many coins, how much gold, does a nation require, and is able to use? The answer for money is the same as for carts or hats. How many hats does England require? Clearly as many as there are heads, and a few to spare. What, then, is the thing which corresponds for coins, as heads for hats? Plainly, the buying and selling carried on by coins, including those needed for banking reserves. There must be currency to perform that work fully, else great inconvenience would arise—some to spare would also be advisable against unforseen contingencies. Beyond this quantity the tools are useless: they have nothing to do; then what becomes of them when brought in by an excess of exports? So long as they remain in England, they are locked up in the Bank of England's vaults: they are wealth for the time annihilated. Meanwhile, how has it fared with England in respect of the exports for which there is so much rejoicing? They consumed a vast amount of wealth in making: food and clothing for labourers were used up, coals were burnt in profusion, materials worked up, and all is gone. What has England in return? some metal locked up in cellars. As long as it remains in England, she is the poorer for these exports. The wealth returns only when the buried gold goes abroad to buy, and then the imports will exceed the exports, and the country is made the richer. Imports alone enrich a country, not exports. To buy gold which cannot be used is as pure an impoverishment for the time, as if the purchasing goods had been given away for nothing. The question always is—Is it worth while to buy this unneeded gold?

We now pass on to paper money—bank-notes. Time fails to examine this form of currency in detail. I will only remark—

1. That there is a large gain to the country by substituting for sovereigns tools costing sixpence for doing the same work.

2. But how is it that paper can do the work, if it be true that money works by double barter, giving value for value? Is this view unsound? Not so. The explanation is to be found in the fact that a sovereign works, not by using the metal of which it is composed, but by the value which it possesses. If twenty persons receive the same sovereign on the same day, each has had the worth of the goods he sold, but the sovereign remained unchanged. Each seller knew that he could melt that sovereign into gold metal and barter it as such, but he did not. The knowledge that he could do so sufficed. Hence, if the sovereign had been placed in a kind of cloak-room, and the ticket received for it had circulated in its stead, the work of exchanging would have been effected equally well by the paper tool. The ticket gave the power of obtaining the metal when desired; that sufficed for each seller.

3. This shows the extreme importance of the sovereign being at hand when demanded. Inconvertible bank-notes are a bad money. They are sure to be issued in excess of what the country wants for buying with. Their value

then becomes depreciated, and very variable. The relations between debtors and creditors, between shop-keepers and their goods, become vitiated, to the great injury and loss of the whole country.

We have now reached the third great instrument of buying and selling—banking. To show its vast importance and power, it is enough to say that payments exceeding 100 millions of pounds are made in the City every week by the Clearing-house, without a penny of money being used. On no other subject connected with trade does such deplorable confusion exist as on banking. What, then, is a bank? a question which few indeed know how to answer. It is an intermediate agency between a lender and a borrower. A banker is best understood if looked upon as a broker between two principals. He brings them together, just like a stock or corn-broker. With what he receives from his customers he first pays the orders for money which that customer makes upon him with pieces of paper called cheques; the remainder he transfers to a borrower. Does he make those payments with money? Does a banker deal in money? Most certainly not. One fact is conclusive on this point, besides the evidence of the Clearing-house. Sir John Lubbock has shown that only three pounds in every hundred were received by the great banking-house of Robarts in cash, and of those three pounds, ten shillings only were money, metallic money. How can a banker pay £100 with only £3 of cash? He does not, and cannot pay the remaining £97 with money. This fact is decisive —a bank does not deal in money, does not receive or pay money, if the word money is to retain its real meaning. How then are the £97 repaid to the depositor? Here lies the secret of all banking. To understand this is to understand banking. Let us consider a complete banking transaction from its origin. A farmer has sold £1,000 worth of corn, and is paid with a cheque, say on Glyn. He places that cheque to the credit of his account, say at Smiths'. How do Smiths obtain payment of this order for money? By asking Glyn for sovereigns? Nothing of the kind. They send it at once to the Clearing-house. This is an office to which the City bankers send the cheques which they have to receive from each other. Every two hours a list is made out for each banker of what he has to receive, or has to pay on the cheques sent in; he settles the balance by receiving or giving a cheque for it on the Bank of England. The Clearing-house acts precisely as a player at cards, who puts down what each man wins or loses on each game. No money passes all the evening; at the end of the playing each man pays or receives the balance which he has lost or won. At the Clearing-house not a sovereign passes, yet a hundred millions of pounds and more are paid and received every week. The debts and payments are settled simply by new items entered in new lines in all the banking books of all the banks. Is this dealing in money, when no money is touched? Is it anything more than machinery for creating and sweeping away debts? But let us proceed further. After the farmer's cheque has been received by Smiths, a borrower, who wishes to buy cotton, comes in, and asks for a loan of Smiths, his bankers. They bid him go and buy £700 worth of cotton, and pay for it by drawing a cheque on themselves. The cotton is bought and paid for by a cheque on Smiths', which is lodged with Glyn, the cotton-dealer's banker. This second cheque is in turn sent by Glyn to the Clearing-house. It meets the cheque of £1,000 which Glyn has to pay to the farmer; Glyn, if no other cheque of his turns up, has to pay the difference of £300, which he does by a cheque on the Bank of England. Thus the whole banking transaction is ended. What has happened? First, not a shilling has passed. Secondly, the farmer has enabled his bankers Smiths to buy; his power to buy they have transferred to a cotton buyer. Thirdly, corn has been exchanged for cotton; the remaining £300 have been transferred to Smiths' account at the Bank of England. Smiths do not lend the whole worth of the farmer's cheque, £1,000, to the cotton buyer, for they know that he will buy things which he will want, and they reserve £300 for these payments. Thus we see the essence of banking; it is machinery for exchanging goods. The goods purchased pay for each other by means of pieces of paper registered in ledgers. Thus banking is a magnificent tool for buying and selling: it does the work fully, yet, even reckoning notes as money, it saves the necessity of buying and employing £97 of currency. Trade thus gains enormously in simplicity and cheapness.

But here the intricacy and danger in banking present themselves. The banker has lent £700 of purchasing power belonging to the farmer, for whom he has found a borrower in the cotton merchant. But the farmer retains the right of demanding his £700 when he pleases, and the cotton merchant may have borrowed on a bill for three months, or may have failed, and be unable to repay his loan. These uncertainties always exist. They call upon the banker to watch the habits of his depositors, and the business of the traders to whom he lends what does not belong to him. These examinations cannot be made with perfect accuracy; and the bank may fall into danger some day. Hence arises the necessity of a reserve—that is, a sum to be retained by the bank, beyond what it lends, to guard against contingencies. This reserve, being the difference between the banker's deposits and his loans, will necessarily take the form of cash, gold and notes. That reserve will vary according to the vicissitudes of business; its fitting amount must depend, as a rule, on the judgment of the banker, according to the signs of the commercial weather. The danger of the bank coming to a stoppage is never absolutely absent; often it may seem uncomfortably near. The banker's profit consists of a charge on the loans he grants, called discount. When danger threatens, he raises this rate of interest, or discount, which diminishes borrowing, and makes many who have previously borrowed anxious to repay their loans. The moral which these facts teach is plainly this—that he should carefully watch and study what is going on in business all around him; how far it is safely conducted, and earning profits; what is the commercial situation of his own and other countries; what forces may be at work diminishing the wealth of the world; what is the position of particular trades and individual firms; what risk there may be of such losses

as may generate a panic and create a run of depositors on banks for the repayment of their deposits. This is the law of right and safe banking, the region in which the thoughts and study of the banker should live. By such vigilance banking will be made rational. Such a banker in America, before the crisis of 1873, would have seen that the American people were rapidly involving themselves in poverty by their excessive construction of fixed capital, laid out on some 30,000 miles of new railways. He would have known that labourers were consuming food and clothing, coals prodigiously destroyed in making iron and machinery, and that the restoration of all this wealth thus destroyed would not be effected by the railways under twenty or thirty years. The nation must be poor, and poor it was, and commercial houses failed, and their fall lost what they had borrowed from banks. Intelligent banking might have prevented the terrible crisis, and its effect on the whole commercial world.

Here we encounter, face to face, the most startling, the most astonishing intellectual phenomenon in the whole world. What commercial profession has such a reputation for intelligence, for ability, for knowledge of the range and intricacies of business. as that of the banker? Yet that great profession labours under a delusion, an ignorance of the nature of its business, of what it really is, unknown to any other branch of trade. It would be most presumptuous and unbecoming in me to use such language, if I stood alone; but what I have preached for years, I have had the advantage of discussing down to the very dregs before the public with a banker of the very highest eminence, an ex-Governor of the Bank of England, Mr. Henry Hucks Gibbs. We had a long correspondence, which Mr. Gibbs first printed at the Bank of England, and then allowed me to publish as an appendix to my last book, "Chapters on Practical Political Economy." The result was a substantial agreement on the great point at issue.

I hope you will allow me to repeat to you a summary of the question, as stated in "Fraser's Magazine," of May, 1880. I could not state it more briefly or more fully:—

"But bankers find it hard to exercise such a cool and commanding judgment on the operations of their borrowers. Then they are men. They encounter keen competition: they can be carried away by the impulses of the day; the prospects look bright: the rise of interest is very stimulating: and then calm reason is easily dethroned. Nevertheless the banking community have not been without the instinct of self-preservation, and they have sought for a rule which should reveal the actual state of trade at the time, and enable them to guide their banking with safety. But, unfortunately, they stumbled upon a purely mechanical rule, a rule of thumb, destitute of common sense; but it lay so close at hand, it was so easy and so natural, and could be worked by the most ordinary brains. They bethought themselves of the reserve of gold, and a banking fact made the rule founded upon it so workable. London bankers do not keep the substance of their reserves in their own hands. They have accounts at the Bank of England, in which they store up their resesves, to draw out whenever they please. Here is the grand metallic reserve of the nation, the supply of gold to preserve all banks from the danger of being asked for money and not having it. The salvation of the banks depended upon it. It must be carefully watched and nursed. If the reserve rises, let loans be freely made and upon lower charges; if the reserve diminishes, let every banker be on the alert. The Bank of England must then raise its rate of lending, and that rate must be the supreme law in every banking parlour. The reserve of the private Bank of England has thus become the king of all bankers. The doctrine has penetrated into every City article of every journal on every day throughout all England, and from England throughout the world. The law is treated as being as certain as the law of gravity. The movements of the gold are recorded as carefully every day for ascertaining the banking weather as the movements of the barometer are published for announcing whether rain or sunshine is approaching. One money market was established for the whole country—the money market of the Bank of England—the other bankers only followed suit. They lent and fixed their interest as the Bank of England directed."

Thus this unhappy absurdity overspread the nation. Its simple rule could be carried out daily with clever comments by every writer of City articles. The common mind could note its mechanics. Then it was very profitable for bankers. The bank rate brought an imperative excuse for levying a tax on all traders, and for an increase of the rate of discount as the reserve fell. It could always be pleaded that they were making the bank safe. It seemed to be an undeniable truth, that every bank which could not pay gold when demanded must become bankrupt.

In answer to this last plea, let us ask categorically, "When does this danger present itself?" Not when business is sound, and no mercantile failures are thought of, even though large sums of gold may have left the reserve. But when the panic has set in, and no one knows what bank may be broken during the day, or what great firm stopped before evening, then is the hour when the strong reserve is most sorely needed, and ought to be most resolutely provided. But what did the Directors of the Bank of England think of their own principle—the avowed governor of their practice—in the greatest of crises, in May, 1866? Did they hug every bag of sovereigns paid in to them, and lock it up in their reserve? They did the very contrary; they lent it out again as fast as they could; and thus, by their own voluntary action—aye, and with the applause of the Bagehots, and the great oracles of currency—they increased their loans from $18\frac{1}{4}$ millions in April to $33\frac{1}{2}$ millions in May, and emptied their reserve from $6\frac{1}{4}$ millions to $\frac{3}{4}$—to less than 1 million; $\frac{3}{4}$ millions of gold, with 33 millions of loans voluntarily given. They then showed, with the greatest plainness, that they had no belief in the necessity of keeping up a great gold reserve, even in the hour of danger. They treated it with contempt by wilfully lending away in the day of peril for mercantile firms almost every sovereign they could lay their hands upon. They knew perfectly well, in the very teeth of the doctrine preached by themselves, the whole City, and every economical journal—that the public, as in 1825, would have been perfectly satisfied with payments in their own bank-notes, under the liberty of issue given by suspension. There was no fear anywhere of the goodness of these notes. With what feelings must any thinking man, any man of common understanding, read those pitiful daily announcements, with their corresponding comments, of a few hundreds of thousands, or even millions,

leaving the cellars of the Bank of England, as if they were anything more than ordinary variations of trade?

The natural action of money is never thought of by the holders of such ideas. Large quantities of money frequently leave the Bank amid profound tranquillity of trade. For what reason? Sometimes because the nation requires more money for currency, as in summer, with its harvestings and travellings, or oftener to pay for an excess of goods imported, or investments made abroad. But what harm is there in all this? Why should it be markedly chronicled as a grave fact, that five millions of gold have been sent to America to pay for sudden purchases of corn required for food? "No harm!" answers Mr. Hucks Gibbs. Money is made for the very purpose of passing from hand to hand, according to the purchases of the day. These five millions are sure to leave America again; they can do her no good in any other way. Her currency was full for the work required before they arrived. Is every trader in England to be warned by every city article, that out of a reserve which amounts to some 45 per cent. of the total liabilities of the bank, a few millions have departed to make purchases abroad? Is there danger, is there bankruptcy, in buying useful goods with gold locked up in vaults? It is lamentable to hear the language used about such events in banking and newspaper regions. Is it not the function of all currency to run? What if by such events the bank's reserve is to fall down to four millions of gold? Is every merchant to tremble in his counting house, every dealer in every exchange? Was anyone frightened about the bank's stopping in 1866, when it had not one million of sovereigns in its possession?

In conclusion, may I venture to say a few more words to you on a subject of extreme importance —the Monetary Conference, which is now sitting at Paris, to promote the universal acceptance of bi-metallism. I will not say, with the eminent economist, M. Leroy-Beaulieu, that this conference is "a gigantic hoax;" but I do not hesitate to declare in the plainest language that this meeting has for its distinct object the making of bad money—false and unreal money—for the whole world. Even one of the advocates of this new system, President Barnard, of Columbia College, has excellently stated that "the real money of the world is bullion;" as has been shown above, the sovereign does its work as the tool of exchange by its worth as a piece of metal—by its value as created by its cost of production.

Now, what is bi-metallism? It is most necessary to have a very clear and definite conception of the meaning of the word, if we are to judge correctly the kind of money it denotes. It is not the mere using by a country of two metals as the tools of its buying and selling. England employs gold and silver coins; but she knows nothing of bi-metallism, and it is to be hoped that she never will. England's money is gold. Her shillings are merely tokens, counters. The definition of a shilling is the twentieth part of a sovereign; the definition of a sovereign is so much weight of gold. The man who buys a ton of coals with a sovereign gives value for value; he who buys a cotton handkerchief with a shilling does not give as much silver as the handkerchief is worth. He gets the handkerchief because with 20 shillings the seller can get a sovereign, and thus he is really paid with gold. The shilling counters act like notes; they mean and are twentieths of a sovereign. They work no harm, because they cannot pay more than 40 shillings worth of debt, and there are not more of them allowed to be in circulation than are sufficient to do the work of small change.

Bi-metallism is a wholly different affair. Its essence is this—that a debtor must accept in payment either of the two metals, in the fixed proportions which the law assigns to them towards each other. England would be bi-metallic if a law were passed authorising any debt to be paid in shillings, and any quantity of silver to be coined into shillings. But what would be the effect; even as matters now stand? Everyone would pay what he had nominally bought with sovereigns, with shillings worth less than 20 to the pound. He could pay with 20, and probably have procured 24 with his sovereign. He pockets four shillings at the expense of his creditor. The ultimate result would be, that silver would be bought abroad with gold to be coined into shillings, which would give every debtor four shillings profit on a pound of debt paid. Sovereigns would then leave England, and goods would be priced in shillings, with an addition of more shillings to the price. The settlement of debts with foreign countries would be most embarrassing, and accompanied by much loss to many; but time fails to enter upon this point.

But the mischief is far from ending here. Even when a nation, as England, has only gold for its money, the uncertainty and greatness of possible loss even now occasion people anxiety as to the payment of debts. We all know the distressing uneasiness created by the presumed decrease in the value of gold. Prices were held to have risen for all articles, and those whose income depended on dividends, whether of Consols or other funds, thought themselves painfully poorer. This is a danger bad enough with one metal for the tool of exchange; it would be increased manifold by the employment of two metals, available at his option to the debtor for the payment of his debt. The bi-metallic shilling might be rated as 24 to the sovereign; but how, if silver is extracted more cheaply from the mines, and the miners would be willing to give 30 shillings for a sovereign's weight of gold? And these variations might be very rapid, and enormous losses might be incurred by creditors, in what they received as their due, both in England and abroad. The misery of changes in the cost of gold alone would be bad enough, but the changing worths of two metals, equally authorised to pay debts in fixed proportion—who can describe the sufferings they might create? Would not the adoption of two standards, as they are called, by the choice of either of two metals by debtors, be indeed a creation of danger and anxiety?

The bi-metallists are aware of this danger, and of the ruin it would bring on the money—the coin—of any country; but they believe that they have discovered a remedy for the evil. The relative value of the metals at present may be assumed, as 1 oz. of gold being equal to 18 ounces of silver; these quantities transferred in exchanges would yield equal worth of metal to each exchanger. It might have been expected that the bi-metallists would have taken their start from this present

equality of 1 to 18; but no; from motives apparently which are easily intelligible to some of their number, they assume the proportion of 1 to $15\frac{1}{2}$, thus giving an excessive, unnatural, unreal, and purely artificial value to silver. They then propose that the nations shall decree that gold and silver coins in that proportion shall be issued, and be each payable for all debts. If the creditor was allowed the option, he would reject the deficient value contained in $15\frac{1}{2}$ of silver for his debt in gold. They do not deny that he would be wronged, but they think they have found the remedy in limiting the coinage of silver so as to make it pass for what they please, and thus enabling the gold and silver coins to be exchanged upon their own selected proportion of value. If a monopoly of all the silver mines could be created, it might be possible to create such a system. Silver might be made scarce in comparison with the demand for it, and thus its value might be maintained at the required proportion of $15\frac{1}{2}$. But such a monopoly is a pure delusion. In any conceivable case, many silver-producing nations would be left out, and they would ruin the projected scheme. They would make silver coins for all the Monetary Union States, forged, but all of full silver weight, introduce them easily into the monetary countries, deluge them with these coins, with immense profit to themselves. Thus silver would become the sole coinage of these countries, and their gold would disappear. The law of all money would then assert itself—prices would all rise—one metal would form that money, and debtors, creditors, and traders of every kind would be delivered over to the extreme uncertainties of the value of silver. The relation of debtor and creditor would become intolerable; and gold would ultimately be restored to its supremacy as money.

Meanwhile, another result would be sure to follow. All goods would have two prices—one in gold, the other in silver; and this last would vary with all the fluctuations of the worth of the metal. What possible motive can be assigned for subjecting the nations to the folly of selecting such money?

But, on the other side, it must be admitted that it is most important to retain the use of silver for the coins of the world. To banish silver altogether, even were it possible, would lead to a great enhancement of the worth of gold, to a scarcity value, in comparison with the work which it would have to do, and many inconveniences would arise. There is only one principle, as far as I know, on which the joint bi-metallic use of silver, in combination with gold, can be carried out successfully, that suggested by Mr. Clarmont Daniell, in his pamphlet, "Gold in the East," and further developed in the *Westminster Review* of January, 1879. He proposes that gold should always be the standard, and remain unchanged; but that silver should also be a complete legal coin for all debts, but in such proportion to gold as shall be determined from time to time by a public authority, according as its intrinsic value, its metallic worth, shall suffer fluctuations. In this manner the creditor will always receive in silver the gold value of his debt, and silver, under such conditions, may be employed without mischief to perform the full work of currency.

DISCUSSION.

The Chairman said they had had a most interesting and instructive paper on a subject which the Society had not discussed much recently, and he thought they would all agree that the Professor deserved their sincere thanks. For his own part, nothing would please him better than to be able to sit under Professor Price in the theatre at Oxford, and learn more thoroughly the principles which he had enunciated. The author had very fully treated of the value of money as a tool for the purpose of exchange, and in the main principles enunciated he entirely agreed with him. Money, after all, was simply a convenient method by which to regulate exchanges. It had a recognised value by which we could regulate exchanges and balance accounts. Trade was simply a system of barter regulated by the exchange of money in order to effect the balance at the end of the year. If that was the case, they arrived at the principles so ably stated in the paper. There were, however, one or two points on which he was not prepared to go entirely with the author. The case of a hat and a sovereign had been mentioned, but he must say he thought a sovereign had an intrinsic value greater than a hat, though the cost of producing it might perhaps be rather less of the two. There was a great deal of labour involved in the various processes of manufacture of the hat, whilst the gold was found in the ground, though of course, it required a certain amount of labour to extract it. It appeared to him there was as much labour required to find a diamond, which was worth several times as much as the gold. Then, again, gold had a certain difference in value. Some years ago he visited Australia, and bought some gold there, which he sold in London at £4 2s. 6d. per ounce, though the standard value, as regulated by the Act of 1844, was £3 17s. $10\frac{1}{2}$d. He got this enhanced price in consequence of what was called the betterness of the gold, and that gold naturally would be valued higher than standard gold; yet it was as easy to produce as gold of lower value. It therefore appeared to him that gold had a value over and above that created by the simple production. This, however, was a point which might be open to question; and he was not prepared to discuss it fully. With regard to bi-metallism, it appeared to him that if, by any means, they could prevail upon the Government of India to introduce a gold standard, instead of a silver one, the effect would be to very much improve the trading relations of this country. It would lead to a considerable absorption of gold in India, and cause the purchasing power of gold to rise here. Silver would be simply used for a token coinage, and for useful manufactures.

Prof. Price said, with regard to the observations of the Chairman, that it was quite true that the finances of India had been very disastrously affected by the fall in the value of silver, because a large proportion of the income of India was fixed, a hundred years ago, at so many hundred silver rupees; and instead of being worth 2s., they were now only worth 1s. 6d. Therefore the Government had to buy at much dearer rates, while its income, which could not be altered, was worth very much less. He knew only one principle on which the object aimed at could be attained, and it was the one referred to at the close of the paper, recommended by Mr. C. Daniell. Gold had a greater intrinsic value than copper, simply because a much greater amount of the latter was produced with a given quantity of labour.

Mr. Pfoundes remarked that in ancient times, not only had skins a fictitious value, but a fluctuating value, according to size and quality, and, therefore, certain ancient American and Eastern tribes adopted the plan of cutting a piece out of the skin, which became a token. That he believed was the earliest known instance of a

token being used in lieu of the thing itself. Again, letters of credit and bills of exchange were by no means modern; they existed in China and the far East in very ancient times; the necessity for not keeping large amounts of capital locked up was recognised nearly twenty centuries ago. He had seen some very ancient bills of exchange in the East, which had passed from hand to hand as money. There was also in ancient times another standard of value, viz., a measure of rice, the standard measure being an average days' ration for an adult. Of course this somewhat fluctuated as there was a scarcity or plenty, but in times of plenty it was stored up against times of scarcity. Besides this, there was an arbitrary standard, which was supposed to represent the value of rice in metal, and it was said that so many days' rations of rice equalled a certain standard of gold, which was the metal *par excellence*. Within his own experience, the Carolus dollar in China was worth from 60 to 70 per cent. more than its actual value in silver during a certain period, and other well-known coins had a value far above their intrinsic value as metal. He might also mention that a paper currency had been issued on the basis of the rice standard, and he once had a large number of specimens, which were now in the possession of the Emperor of Austria, of this old paper currency; the different notes or tickets representing one day's ration, one and a-half days', five, or ten days' rations of rice, and these passed from hand to hand. It was a curious fact, that when the English established a mint in Hong Kong, they were obliged to close it, most of the *employés* being sent to Japan, because the Chinese would not adopt the currency, and he believed most of the gold and silver coins went to adorn the jackets of young swells in Canton.

Mr. Robert Manuel said Mr. Price had described the object of the Conference now sitting in Paris as an attempt to foist silver money on the world at a fictitious value. He must admit that, when its actual value was in the ratio of 18 to 1 of gold, and they were trying to get it into circulation at 15½ to 1, that course could not be justified; but was not the ratio of 15½ to 1 a fair one, taking the old value of the silver? And they had to consider why silver had fallen in value. Was it not, to a great extent, due to the action of the German Government, who, some ten years ago, finding themselves rather flush, thought they would demonetise their silver and adopt a gold standard. They were, perhaps, wise in doing so, but the result was to flood the market with silver, and it was well known to those who dealt in bullion that the German Government had now in their coffers silver which they they were waiting to sell when opportunity offered, and this was always a bugbear in the silver market, and kept down the price. He would not urge that our Government should adopt bi-metallism, because we got on very well with gold; but it must be borne in mind that, if the suggestion of a gold currency in India were adopted, it would make such an enormous demand on the stock of gold—which was not by any means too large for the requirements of western civilisation—that it would appreciate to a serious extent the value of the metal. Again, the habits of the people of India were different to those of the west; there was a tendency amongst Hindoos to hoard, and if they had a gold currency, they would hoard gold as they did silver; and being smaller in bulk, the effect would perhaps be worse. He would ask whether it would not be better for the world in general if those nations which were willing to act on the bi-metallic principle fixed on some ratio—if 15½ was not fair, say 16 or 16½ to 1, or something approaching the actual ratio, and by that means re-introduce silver into the currency, which would then force up silver to something like its old value. We should have our one gold standard, and in India there would be a silver standard, but the Government would save the loss on the exchange, which now amounted to about three millions a year.

Mr. Wm. Botly said the last speaker had stated the principles on which he should have addressed the meeting, and he would merely add that, having listened to Colonel Smith's paper on bi-metallism, he was rather inclined to the opinion that if silver were made 15½ to 1 of gold, it might be a great advantage to this country. If the legal tender of silver were raised from £2 to £5, it would be a great convenience, and would remove the prejudice which was now felt against it. With regard to India, he feared it would be almost impossible to adopt a gold standard with advantage; but the rupee might be made of varying weight. It would be impossible, in a country like India, to do better than raise silver in value.

Mr. Hedley Millyard said the Professor stated that gold purchased by reason of its cost of production, but if that were so, gold must be taken as a marketable commodity in exactly the same way as any other, and you might substitute for gold in that proposition a bale of cotton piece goods. Then it amounted to this, that a bale of cotton bought by virtue of its cost of production; but it had been proved as clearly as the *pons asinorum*, that its sale was simply regulated by the demand for it. The question of the purchasing power of gold cropped up again when the great point was discussed whether gold had of late years become cheaper or dearer. It would seem that the only data they had for determining the purchasing power of gold, was its primeval distribution, which it was impossible to deal with other than deductively. They had no data by which they could treat the question inductively as to whether gold had been dearer or was now cheaper. Whether the gold discoveries of late years had tended to neutralise any deficiency which might have come about in the currencies of the world in consequence of wear and tear, was a question for economists to determine deductively. The Professor had laughed at the alarm which was felt in mercantile circles, at the question of whether our imports exceeded our exports, but he did not think the question was quite to be settled in that way. Some years ago there was an instance when the Bank of England was simply saved by borrowing two millions of gold from the Bank of France, and that clearly showed that there were some specific phenomena by which they could gauge this question. It showed that an efflux of bullion might go on unperceived, and only be made known in the event of a commercial crisis. In that case clearly we were not aware of the position of the Bank of England, and it was very problematical whether the proposition were true if we took departments of mercantile statistics. Take the carpet trade, and the position of that trade with America. It could not be said that the fact that our imports exceeded our exports was beneficial to this country, inasmuch as, for protective purposes, our goods were practically shut out from America altogether.

Mr. M. S. S. Dipnall thought the imperishability of gold had been rather overlooked in considering its value. If you took hats, umbrellas, or shoes, and locked them up in a closet for a hundred years, they would be absolutely worthless, probably they would be nothing but dust whereas a sovereign would be as good as the day it was coined. The subject of bi-metallism was not one which he had much studied, but it struck him that, comparing sovereigns with shillings, there would be a vast deal more wear and tear in the latter representing the same value, and therefore there must be some disparity between the value of the two metals for purposes of coinage from that point of view alone. With regard to India, there could be no doubt that many men there had to suffer for the depreciation in silver, owing to the accident that their contracts were made in that metal; it was a thing they all deplored, but he did not see how it was to b

remedied. With regard to the Chairman's remarks about Australian gold being worth £4 2s. 6d. an ounce, that was on account of its greater purity; the standard gold was worth £3 17s. 10½d., and if gold were found of greater purity, clearly the owner was entitled to the advantage. He did not readily see how two distinct currencies could exist in any fixed ratio to each other, for any length of time together.

Mr. Paterson remarked that Professor Price seemed to think that by having a gold standard they were not exposed to the inconvenience of fluctuation in the value of debts; but suppose the commercial value of gold were greatly changed by some discovery which should facilitate its production on the one hand, or, on the other, should make it more valuable, the value of debts measured in gold would then change accordingly. If they used wheat, or cotton, or anything else as the standard, they would be always exposed to the same difficulty. Gold happened to be a little more staple, perhaps, but he believed the use of it as a standard concealed its fluctuations, and that there was little more advantage than that in it. It was said that silver coins were mere tokens, but he thought it would be almost impossible, even for a powerful Government, to substitute any cheaper metal. The silver shilling might not represent precisely the value it was supposed to represent, but it approached very closely to such representation. With regard to the question of exports and imports, he differed somewhat from the Professor, when he said we were not to be alarmed because our imports were in excess, because it showed we were getting richer. The question was, what was meant by getting richer? It was said we were now receiving the interest on capital which was invested in New Zealand, America, and other places. But what was the process by which this capital was invested there? Was it not by the exports greatly exceeding the imports for a considerable time? We sent out steam-engines and a great many other things, as investments, from which we were now receiving the interest, and that was the process by which we got rich. But now, when we were receiving more imports, the question was what kind of imports they were, whether we were getting richer or poorer, and whether or not we were spending the capital which was invested abroad. Suppose that this country invested very large sums in American securities during the American war; most of it was sent out in the form of merchandise; and were they not, at that time, getting richer? Then, during the time of bad harvests, if we received a very large proportion of our wheat from America, and consumed it, it seemed to him, that at the end we might have eaten up, in the shape of wheat, what we had invested in former times, when goods were sent to America; and that seemed to him a process of getting poorer, and not richer. At any rate, this was the defence of those who thought that an excess of imports was not a healthy state of things.

The Chairman having proposed a vote of thanks to Professor Price, which was carried unanimously,

Professor Price, in reply, said he quite agreed with those gentlemen who desired that both silver and gold should be used. The supply of gold was too small for all the purposes of currency, and without the aid of silver it would acquire an artificial and improper value. All he meant to say was that he did not know of any other way in which the two metals could be worked together than that of one being taken as the standard, and that the other be adapted to it, in proportion to its cost of production. Mr. Daniell's idea was that a very small stock of gold should be used in India, and that a large quantity of silver should be used as before, but that the payment of debts in silver should be adjusted according to the proportion which silver bore to gold. With regard to token coinage, in Austria and elsewhere, there were shilling and even fourpenny notes, and they answered perfectly well, except that they got dirty and torn, and were hard to distinguish. A hard token like silver had a great advantage from its durability. He could not answer Mr. Hillyard's questions without going into the whole subject of banking, which was too large a one to enter upon then. One of the reasons why a large supply of coin was not wanted in England was that our machinery of payment by means of cheques, and the Clearing-house system, was so perfect; but all this was arranged on the basis of a gold standard. With regard to exports and imports, of course they might have various motives, but those who made investments abroad were not the people who talked about exports and imports, it was always the traders, and as a matter of trade, the advantage was in the imports. Debts might be paid this year or next, or in ten years time, but the exchange was always of goods. If England made foreign loans, it was always in goods; she had no superabundance of gold to send abroad. If she had spare goods, it might be a good investment to send that extra store got by saving and productive consumption abroad as exports, with the intention of the equivalent not coming back, but that was not the language of the mercantile world to which he was alluding. Imports might be like American wheat, which supplies the place of a great destruction of wealth here. There was no doubt we had had very defective harvests, and the alternative was either to buy corn abroad or starve. Of course he did not mean to say that the buying American corn under such circumstances was a sign of prosperity, but it was an excellent purchase nevertheless, and the importation was a source of wealth, because it kept the nation alive. The loss was not in the importation, but with the loss of the harvest. But that was not the question with which he was dealing. The principle always remained the same; trade was an exchange of goods and nothing else whatever.

GENERAL NOTES.

The Commerce of London.—Sir John Lubbock has communicated to the papers the following account of the operations of the London Bankers' Clearing-house for the year ended April 30:—

"15, Lombard-street, May 2.

"Sir,—I beg to forward you the subjoined statistics, showing the working of the Bankers' Clearing-house for the year ended on the 30th of April, 1881, which is the 14th during which these statistics have been collected. The total amounts for the 14 years have been—

	Total for the Year.	On Fourths of the Month.	On Stock Exchange Account Days.	On Consols Settling Days.
	£	£	£	£
1867-1868	3,257,411,000	147,113,000	444,443,000	132,293,000
1868-1869	3,534,039,000	161,861,000	550,622,000	142,270,000
1869-1870	3,720,623,000	168,523,000	594,763,000	148,822,000
1870-1871 ...	4,018,464,000	186,517,000	635,946,000	169,141,000
1871-1872	5,359,722,000	229,629,000	942,446,000	233,843,000
1872-1873	6,003,335,000	265,965,000	1,032,474,000	243,561,000
1873-1874	5,993,586,000	272,841,000	970,945,000	260,072,000
1874-1875	6,013,299,000	255,950,000	1,076,585,000	260,338,000
1875-1876	5,407,243,000	240,807,000	962,595,000	242,245,000
1876-1877	4,873,000,000	231,630,000	718,793,000	223,756,000
1877-1878	5,066,533,000	224,190,000	745,665,000	233,385,000
1878-1879	4,885,091,000	212,241,000	811,072,000	221,264,000
1879-1880	5,265,976,000	318,477,000	965,533,000	233,143,000
1880-1881	5,909,989,000	240,822,000	1,205,197,000	265,579,000

The total amount of bills, cheques, &c., paid at the Clearing-house during the year ended April 30, 1881, shows an increase of £644,013,000 as contrasted with 1880. The payments on Stock Exchange account days form a sum of £1,205 197,000, being an increase of £239,664,000 as compared with 1880. The payments on Consols account days for the same period have amounted to £265,579,000, giving

an increase of £32,436,000, as against 1880. The amounts passing through on the 4ths of the month, for 1881, have amounted to £240,822,000, showing an increase of £22,345,000, as compared with 1880. At the same time I may observe that four Consols settling days fell on 4ths of the month, while there only happened one last year. This would account for a considerable portion of the increase. Messrs. Derbyshire and Pocock, the inspectors of the Clearing-house, have been good enough to prepare for me the above figures, which will, I think, be interesting to many of your readers.—I am, sir, your obedient servant,

"John Lubbock, Hon. Sec. London Bankers."

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

May 11.—"The Manufacture of Glass for Decorative Purposes." By H. J. Powell (Whitefriars Glass Works).

May 18.—"The Electrical Railway, and the Transmission of Power by Electricity." By Alexander Siemens. Dr. Siemens, F.R.S., will preside.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

May 10.—"Trade Relations between Great Britain and her Dependencies." By William Westgarth. Lieut.-Colonel Sir Robert R. Torrens, K.C.M.G., will preside.

Applied Chemistry and Physics Section.

Thursday evenings, at eight o'clock:—

May 12.—"Recent Progress in the Manufacture and Applications of Steel." By Prof. A. K. Huntington.

May 26.—"Telegraphic Photography." By Shelford Bidwell. Prof. W. G. Adams, F.R.S., will preside.

Indian Section.

Friday evenings, at eight o'clock:—

May 13.—"Burmah." By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B. Sir Rutherford Alcock, K.C.B., will preside.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Fourth Course will be on "The Art of Lace-making," by Alan S. Cole. Four Lectures.

Syllabus of the Course.

Lecture IV.—May 9.

Resumé as to styles of design in hand-made lace. Traditional patterns. Sketch of the development of inventions for knitting and weaving threads to imitate lace. Differences between machine and hand-made laces. Modern hand-made laces at Burano, Bruges, Honiton, &c.

This course will be illustrated by specimens of lace. Diagrams and photographs enlarged will be shown by means of the lantern and oxyhydrogen light.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 9th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. Alan S. Cole, "The Art of Lace-making." (Lecture IV.)
Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. Edward Whymper, "A Journey amongst the Great Andes of the Equator."
British Architects, 9, Conduit-street, W., 8 p.m. Annual General Meeting.

Tuesday, May 10th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Mr. William Westgarth, "Trade Relations between Great Britain and her Dependencies."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Non-Metallic Elements." (Lecture III.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. John I. Thornycroft, "Torpedo Boats and Light Yachts for High-Speed Steam Navigation."
Photographic, 5a, Pall-mall East, S.W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Prof. G. Dancer Thane, "Some Naga Skulls." 2. Lieut.-Col. R. G. Woodthorpe, "The Wild Tribes of the Naga Hills."
Royal Colonial, Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Sir Charles Nicholson, "The Principle which ought to regulate the determination of the Political and Municipal Boundaries and Divisions of the Colonies."
Royal Horticultural, South Kensington, S.W., 1 p.m.

Wednesday, May 11th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. H. J. Powell, "The Manufacture of Glass for Decorative Purposes."
Geological, Burlington-house, W., 8 p.m. 1. Mr. James W. Davis, "Notes on the Fish-remains of the Bone-bed at Aust, near Bristol, with the Description of some new Genera and Species." 2. Rev. P. B. Brodie, "Certain Quartzite and Sandstone Fossiliferous Pebbles in the Drift in Warwickshire, and their probable identity with the true Lower-Silurian Pebbles, with similar Fossils, in the Trias at Budleigh Salterton, Devonshire." 3. Mr. Francis D. Longe, "Some Specimens of *Diastopora* and *Stomatopora*, from the Wenlock Limestone." 4. Prof. W. J. Sollas, "A New Species of *Plesiosaurus* (*P. Conybeari*) from the Lower Lias of Charmouth."
Microscopical, King's College, W.C., 8 p.m.
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Ascham, 18, Baker-street, W. Prof. Henry Morley, "The Place of English in a Liberal Education."

Thursday, May 12th ... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Applied Chemistry and Physics Section.) Professor A. K. Huntington, "Recent Progress in the Manufacture and Applications of Steel."
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m.
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Dr. Phené, "Art Exhibitions."
Royal Institution, Albermarle-street, W., 3 p.m. Prof. Tyndall, "Paramagnetism and Diamagnetism." (Lecture III.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Mr. W. R. W. Roberts, "Note on the Co-ordinates of a Tangent Line to the Curve of Intersection of Two Quadrics." 2. Mr. E. Carpmael, "Some Solutions of the 15 School-girl Problem." 3. Mr. C. W. Merrifield, "Note on Ptolemy's Theorem." 4. Mr. C. Hudson, "Algebraical Notes." 5. Rev. T. R. Terry, "The Summation of Certain Hypergeometric Series."

Friday, May 13th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) General Sir Arthur Phayre, "Burmah."
Royal United Service Institution, Whitehall-yard, p.m. Captain J. R. Colomb, "Naval Intelligence, and the Protection of Commerce in War."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. F. Galton, "Mental Images and Vision."
Astronomical, Burlington-house, W., 8 p.m.
Folk-Lore, 22, Albemarle-street, W., 8 p.m. Mr. H. B. Wheatley, "The Superstitions of Pepys and his Times"
Clinical, 53, Berners-street, W., 8½ p.m.
New Shakspeare, University College, W.C., 8 p.m. 1. Rev. J. Kirkman, "The Suicides in Shakspeare's Plays." 2. Mr. F. J. Furnivall, "The Cruxes in Shakspeare's early Comedies."
National Health Society, 23, Hertford-street, W., 4 p.m. (Drawing-room Lectures.) Mr. H. Power, "Care and Education of the Eye."

Saturday, May 14th...Physical, Science Schools, South Kensington, S.W., 3 p.m. Prof. H. A. Rowland and Mr. E. H. Nichols, "Electric Absorption in Crystals."
Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.
Geologists' Association, University College, W.C. Excursion to Croydon.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Henry Morley, "Scotland's Part in English Literature." (Lecture III.)

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, MAY 13, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Thursday, June 2nd. The cards of invitation will be issued shortly.

CANTOR LECTURES.

The fourth and concluding lecture of the fourth Course, on "The Art of Lace-making," was delivered by ALAN S. COLE, on Monday, 9th inst. The lecturer gave a *resumé* of his subject, and pointed out the variety of styles of design in hand-made lace. He then described the development of inventions for knitting and weaving threads to imitate lace, and showed the distinctive differences between machine and hand-made lace, by means of the enlarged photographs shown on the screen. He concluded with a notice of the modern hand-made laces of Burano, Bruges, Honiton, &c.

Some fine specimens of lace, kindly lent by Mrs. Alfred Morrison, Messrs. Hayward, and Messrs. Howell and James, were exhibited on the table.

A vote of thanks to Mr. Cole, for his interesting course of lectures, was proposed, and carried unanimously.

ART FURNITURE EXHIBITION.

The preparations for the Exhibition of Works of Art applied to Furniture at the Royal Albert Hall are now nearly completed. The Exhibition will be opened on Monday, May 16th, at the same time as the General Art Exhibition at the Albert Hall.

PLANT LABELS.

In response to the offer of a medal and prize of £5, for the best labels for plants, labels have been received from 120 competitors.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Dr. Hullah, the Society's Examiner, at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 4th July, 1881.

HONOURS.

The Examination in Honours will consist of three sections, viz., a paper to be worked, an examination similar in form to the practical examination for a First and Second-class, and a *viva-voce* examination.

FIRST AND SECOND-CLASS.

Vocal.

Candidates for a First or Second-class Certificate in Vocal Music will be required—

[1.] To sing a solo, or to take part with another candidate in a duet, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, or successions of sounds or intervals, played or sung by the Examiner.

[3.] To sing or sol-fa at sight passages selected generally from classical music.

Instrumental.

Candidates for a First or Second-class Certificate in Instrumental Music will be required—

[1.] To play a short piece, or a portion of a larger work, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, played by the Examiner.

[3.] To play a piece or portion of a piece at sight.

The fee is 10s. for the Honours (including both vocal and instrumental Examination), and 5s. for the First or Second-class (vocal or instrumental) Examination. If vocal as well as instrumental music, or two separate instruments, be taken by the same candidate for the First or Second-class Certificate, a fee of 7s. 6d. must be paid.

The examination of each candidate will be private; no one but the Examiner and the accompanyist being present, unless it be a member of of the Society of Arts' Committee.

No list of Candidates will be published.

Full particulars can be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

FOREIGN AND COLONIAL SECTION.

Tuesday, May 10th, 1881; James A. Youl, C.M.G., in the chair.

The paper read was—

TRADE RELATIONS OF THE COLONIES AND THE MOTHER COUNTRY.

By William Westgarth.

Introductory Remarks.

In presenting adequately to my audience the great subject I have ventured to take in hand, it will be necessary to begin with a few introductory and explanatory remarks upon the colonial or external parts of our Empire. The importance of that part of the British Dominions cannot be better illustrated than by the fact that it comprises forty distinct societies and governments, whose united public yearly revenues are over 90 millions sterling, with a total yearly trade of 320 millions; that it covers an area of nearly nine millions of square miles, or about one-seventh of the whole land surface of our globe, with a population of 254 millions, or no less than between one-fifth and one-sixth of that of the whole world.

But first let me make here a passing comparison with the illustrious mother of the family, who, indeed, cannot fail to be illustrious, even if she were nothing more than the mother of so great and varied a household. But she has, besides, her own attainments to stand upon. Within an area only 1-75th of that of her family, and a population of between a seventh and an eighth, she now creates, within that comparatively small space of about 120,000 square miles, a yearly public revenue of more than eighty-four millions; and with 633 millions of yearly trading, has nearly twice the amount of the united total trading of all her vast family.

This colonial family is most variously—indeed, picturesquely—constituted, embracing, as it does, very large proportions of other races than our own, a great variety of climate and production, and no small diversity in social and political aspects. I distinguish three leading classes of our outside possessions:—1st, Colonies proper, consisting substantially of societies of our own race. These are, respectively, the North American group, now all, with only the one exception of Newfoundland, comprised in the Canadian Dominion; the Australasian group, and the Cape Colony. All these enjoy a reflex of our own system of constitutional self-government, subject, of course, to imperial supremacy. 2nd, Dependencies of substantially foreign races, which, as the rule, are not constitutionally governed, that is to say, by popular representation, but by a system of Crown nomination, and, therefore, distinguished as Crown Colonies. Of these, our great leading figure is India; and we have, besides, Ceylon, the Straits Settlements, Mauritius, Natal, the West Indies generally, Guiana, Honduras, Sierra Leone, Gold Coast, and some others. 3rd, Military Colonies, as Gibraltar, Malta, Cyprus, Bermuda, Ascension, St. Helena, &c. I might have found yet a fourth class in convict colonies, such as Bermuda still continues; but as that is now an expiring system, I have included its remnants in the military class. Within only the last forty years, however, the convict system has included, besides Bermuda, New South Wales (with its offshoot, Norfolk Island), Tasmania, and West Australia.

No clear line, however, separates these three classes from each other. There is partial representative privilege in some of the Crown Colonies. It might be puzzling in which class properly to put little St. Helena, although I have given her to the military. Then, again, there are great and at times disturbing foreign social elements, in our free or constitutional colonies. The aboriginal native element in Canada is of no political import, but there is a large although happily a loyal French element. In Australia again, the aborigines have never raised a political question, but the case has been very different in New Zealand; and lastly, in our Cape dominions we have had, and still have, most embarrassing relations with both the Dutch and the aboriginal elements.

Mode of Treating the Subject.

Our view of the trade relations of our colonies to the mother country would be quite incomplete if we omitted allusions to these political circumstances, connected as they are too with that important but interminable tariff question, which springs up everywhere over the colonial ground, and which claims our attention equally with the trading which it affects or regulates. I propose, therefore, to present my subject in the following order:—

First, we shall look at the progress and present attainments of the trading between the mother country and the colonies, with a comparative glance at the foreign trading.

Second, we shall examine some of the chief features and chief items of all that trading.

Third, we shall consider the trade relations, in regard, mainly, to the relations, complexities, and difficulties of the tariff question.

Fourth, and lastly, we shall make some general reflections on the whole case.

I am aware that this Society excludes political controversy from its proceedings; and most properly so, seeing that the great political parties of the country may equally meet within the Society's walls, to promote its many national and general objects. But the large and varied colonial question, when we have occasion to touch upon any part of it, is happily, as you will find, not a political one, in the objectionable sense of home political parties.

I have yet one further introductory remark. My subject bristles with facts and figures, and a too common fault of papers of this kind is to overload and weary the memory in that way. I have carefully tried, and I hope successfully, to avoid that fault, while at the same time not withholding such sufficiency of statistical illustration as may do full justice to my subject, and make it fully intelligible to my audience.

I.—PROGRESS AND PRESENT POSITION OF THE TRADING BETWEEN THE MOTHER COUNTRY AND THE COLONIES, AND COMPARISON WITH FOREIGN TRADING.

Two Remarkable Features.

In glancing over the figures presented by our commerce, we are at once struck by two different and remarkable features; one, the largeness of the amount as compared with that of other countries, and the other the comparative velocity of the pace of increase or progress in these later years. In the amount of our total trade, that is to say, of our combined imports and exports, our country is far beyond any other country in the world, not excepting even such advanced commercial countries as France and the United States, although their thoroughly organised, industrious, and highly intelligent populations respectively exceed our own. While our total trade for 1880, exclusive of coin and bullion, reached 633 millions, that of France for the same year was £332 millions, and that of the United States 317 millions. If to the above figures of our United Kingdom we add the 320 millions of the aggregate colonial trading, we attain to nearly 1,000 millions for the whole empire, an amount that makes a very substantial approach to the total trading of all the rest of the commercial world put together.

The other striking feature, that of the accelerated progress of the later years, is so interesting, more especially as it appears to be common to the other foremost nations of the day, that I shall hope to be excused if I dwell here for a moment upon it. Let us look back only twenty years. Our country's trading, now 633 millions, was then but 347 millions; that of France, now up to 332 millions, was then only 157 millions; and that of the United States, now at 317 millions, was then but 143 millions. Although our country now stands commercially so far ahead of any other in the world, there can be no doubt that if, like Rip van Winkle across the Atlantic, we were to drop asleep for a score of years, or perhaps even for but the one-half of that short space of a nation's life, we should awake to find that France and the United States had both overtaken or surpassed us. By so short a step ahead in this inspiring race is our present supremacy held.

This remarkable accleration of commercial pace, as regards our own particular case, appears to have begun about half a century ago. The acceleration has indeed been of a general as well as a merely commercial nature, and has been applicable alike also to social, political, and scientific progress. Our great colonial developments also are mainly within that brief space. In 1830, Canada had but small pretensions compared to the present four millions of colonists, five millions sterling of yearly revenue, and fifty-five millions of yearly trade. The wide and expanding Cape settlements, now so conspicuous for wool and other products in the empire's commerce, were then, industrially considered at least, an almost empty space, hardly more than geographically familiar to us. Australia was known here as being little more to us than the two convict settlements of New South Wales and Van Diemen's Land (now Tasmania); whilst the newest member of the group, New Zealand, contained, colonially speaking, but a handful of adventurers and missionaries, the latter of whom in particular, as Sydney Smith, in his characteristic way, has humorously reminded us, served occasionally as choice delicacies on the sideboards of cannibal natives. But already, Australasia, with three millions of colonists, sixteen millions of yearly revenue, and ninety millions of yearly trading, is casting even Canadian progress into the shade.

In this remarkable feature of a greatly accelerative progress, the colonies generally are stepping ahead of, and in some cases—as in the instances given—even much more rapidly ahead proportionately than the mother country herself. We may have some reflections to offer on this portentous condition and prospect further on. It is portentous, but by no means unwelcome or alarming. But turning, meanwhile, once more to the home picture, we see the acceleration in question fairly illustrated by the progressive statistics of our shipping. The collective outward and inward tonnage for the United Kingdom, exclusive of the coasting trade, appears as follows, prior to and after 1830, or fifty years ago:—For 1814-16, the yearly average was 4·3 millions of tons; for 1820, 5·3; for 1830, 5·8. Thence, entering the era of marked acceleration, we have for 1840, 9·4; for 1850, 14·5; for 1860, 24·7; for 1870, 36·6; for 1878, 51·6. In the total trade also we show the same remarkable later acceleration; and we have that feature in common with France and the United States, whose cases have been just alluded to; for while our present amount is 633 millions, 25 years ago it was but 289 millions, or considerably less than the amount to which either France or the States have now attained.

The Uncertainty of Past Official Trade Records: "Official" and "Real" Values.

Allow me here a few words upon a very important, but not much understood, subject, namely, the uncertainty, or rather the totally misleading effect of the system of our earlier official trade records, and more especially as to the import trade prior to the year 1854. I have pleasure in acknowledging that I owe the information I am now giving you chiefly to my friend, Mr. Stephen Bourne, the able and practised statistician of our Customs' department. We are still lingeringly familiar with the alternative terms "official" and "real" values in our import and export figures; for until 1869, when the "official" were given up, both used to be presented to us. We may readily guess at the meaning of real, but what are "official" values? The old or original Custom-house practice was to keep the respective values unchanged, as they were handed down from past years, no matter what change in price had really occurred in the interval in the articles imported or exported. When a new article appeared in the list, its value at the time was recorded, but at that value or price it afterwards unchangeably stood. In this way we have complete returns dating from 1699, but returns utterly unreliable, except in a comparative way, not as to value, but as to quantity. Fortunately, a "real" value for the exports has come concurrently down to us with the "official" value from 1798. A real value was then first required for the purposes of a war tax in that belligerent time for convoys to merchant

ships, and this real value system as to exports was, happily, afterwards kept up. The difference between the two values gradually accumulated to a ludicrous extreme; for at the last record in 1869, while the real value of our exports was 237 millions, the official value had run up to 456 millions.

The imports, on the other hand, are simply and solely "official," up to 1854, at which time, while this official value was but 124 millions, the real value had attained to 152 millions, showing the first to be about 23 per cent. short. As Mr. Bourne remarks, the exports had been progressively cheapened by competitive production, and the imports advanced by greater demand and larger means of purchase. In 1854, there was added to the official value system that of a "computed" real value. It was only in 1872 that the imports as well as the exports were returned by "declared" real values. Considering how long it lingered in life, into these modern advanced and common-sense times, the official value record is one of the most curious in red tape annals. As one instance of uncertainty in the utter divergency from fact, we may quote the official value of the imported article wood in 1854 as being £1,812,690, while the real value turned out to be no less than £11,064,694. In another instance, that of the article tea, the real value is exceptionally a reduction instead of an increase, for it is £5,540,735, while the official value is £8,579,203. Thus, tea had become considerably cheaper since it was enrolled as an import in our Customs list, while wood had become very much dearer.

The colonial Customs returns, so far as I can learn, appear to have been always kept in that common sense correctness of real values to which we at home have at last happily attained. But as regards the home figures, while those of exports are reliable for above 80 years past, those of imports, on the other hand, cannot be trusted till as far on as 1854.

Our Colonial versus our Foreign Trade.

In viewing the great trade of our country, we are, of course, for the present more particularly interested in the proportion of it which is concerned with the colonies. Our free trade system, which is unquestionably the chief cause of our trading supremacy in the world, gives as yet much larger proportions to our foreign than to our colonial trading. Thus, while our total trade of 1879 is 612 millions, the colonial portion is 146 as against 466 foreign. Nor is there much difference in these proportions during the last quarter of a century—for in 1855 they are 62 and 198; in 1865, 124 and 366; and in 1875, 161 and 495. The returns, however, give a tone of cheerful progress. While, in 1855, the total of imports from colonies is 34 millions, in 1879 it is up to 79 millions, and in the same way the exports to colonies are respectively 28 and 67 millions.

But if the totals of the colonial figures are still so considerably below those of the foreign, we find an extremely different result when we take the amount of trading as per head of population. In this way Canada, at 32s. per head, takes from us four times more than the United States. And again, while our 15 millions of exports to France are but little different from about 16¼ millions to Australasia, yet, in point of population, the true difference is as about 8s. to about £6 per head.

II.—Chief Features and Principal Articles of the Trade between Mother Country and Colonies.

Colonial Raw Materials and Home Manufactures.

As we should theoretically expect, so we actually find, that our colonies and dependencies send us raw materials, and that, in return, we of the mother country, with our larger capital, and better organised and more abundant labour, send back to the colonies these raw materials in a manufactured state. This is remarkably the case with wool, an article at once of the highest importance and of enormously increasing colonial production at the Cape and Australia. It is the case also, although in less marked degree, with our West India and some other colonial raw sugars. It is still so to some extent, too, with cotton from India; although latterly, with our full supplies resumed from America since the Civil War, the importations from India have greatly fallen off. We get now only about four million pounds' worth yearly of Indian cotton, whereas, in our extremity caused by the American failure 15 to 20 years ago, this source of supply gave us no less than 30 to 40 millions value. But the intertrading between mother and family is already of a very varied as well as extensive and increasing character, notwithstanding the extreme youth, comparatively speaking, of most of the colonies. The latter, indeed, are already not generally satisfied to remain mere producers of raw materials. At the great International Exhibition held within the last two years at Sydney and Melbourne, the colonies, with laudable spirit, entered upon a successful competition with England and other European countries in well nigh all the leading industries of these old-established commercial states.

The general progress of colonial trading, just as we have already seen in the case of our home trading, is fairly indicated by the official shipping and tonnage returns. Official returns from 1862 to 1876 of outward and inward tonnage, exclusive of coasting trade, exhibit alike a fair scale of business, as well as the usual feature of progress. The increase for the 15 years' averages, in most cases, nearly one hundred per cent. In India, from 3·4 million tons the advance is to 5·2 millions; Australia, 3·4 to 6·6; British North America, 5·2 to 6·6; West Indies, 1·3 to 2·4. Then we have our military ports of call, Gibraltar and Malta, with also their considerable and progressive figures; the former from 2·2 to 4·2, the latter from 2·2 to 5·2. Of this total tonnage, in these cases, the proportion that is British averages about two-thirds.

What the one sends to the other.

Turning to the merchandise account, let us first look at what this country sends to the colonies, and next, at what the colonies send to her in return. With our colonies in general, the larger proportion of their exports is sent to the mother country. With the latter, on the other hand, her foreign commerce still absorbs by far the larger portion—in the ratio, indeed, of as much as nearly 3 to 1. How the future is to affect this ratio must be matter of experience. Our colonial commerce

is remarkable for its steadiness, not only in average results, but even in the case of each individual colony or group. In this respect it is markedly the more reliable element to us of the two. The very noticeable falling off in our exports, and the not less abnormal increase in our imports, for the last five years, whatever it may all mean, if indeed it have other than a temporary or merely reactionary signification, is entirely a foreign and not a colonial irregularity. It is, however, a feature of sufficient interest to call for some reflections under our fourth and last head. With these explanatory remarks, let us proceed to glance at the chief components of the great trade of our country. It may be understood that, of the quantities here given, rather more than one-fourth, on an average, are sent to our own possessions, and the rest to foreign places.

Mother Country sending to Colonies.

By far the most important article in our export trade is cotton, in its manifold diversities of fabrication. At considerable distance, but still with large figures, come next the varied woollen fabrics. Those of linen are, comparatively at least, unimportant. We have further a substantial amount under the head of iron and steel products, whose total, exclusive of that of the lighter articles of hardware and cutlery, is close up to that of the woollen industry. These three great classes of articles then, namely, cottons, including cotton yarn; woollens, including woollen yarn; and iron and steel productions, constitute the conspicuous divisions of our export trade. In 1879, they comprised together a total of 103 millions out of a grand export total of 192 millions. The cottons amounted to 64 millions, the woollens to 19½ millions, and the iron and steel to about the same. A few of the groups of less value are apparel and haberdashery 8 millions, coal and fuel products 8 millions, linens and yarn 6½ millions, and hardware and cutlery 3½ millions.

Colonies sending to Mother Country.

Turning now to the other side, the chief raw products of our colonies for a number of years past have been sugar and wool. Since 1851 we have been prominently conspicuous in Australasia as gold producers. More recently we have high promise of great business in wheat and other breadstuffs from South Australia and New Zealand, as well as Canada from her boundless corn lands of the far West. Not less important, perhaps even still more so, is the prospect of our animal food importation, by some of the advanced scientific modes of live-stock production now being vigorously tried in Australia, where ten million head of cattle and 70 millions of sheep are already in waiting for us.

Our colonial sugar production, in spite of great increase of home consumption, seems somewhat stationary. Nearly the whole export comes to England; but the 7,347,000 cwts. exported in 1862 had grown to only 7,878,300 in 1876. Wool production, however, presents a much more lively, indeed an extraordinary, progress. The 127 millions of pounds weight exported (also nearly all to this country), in 1862 had risen to 413 millions in 1876, an amount sufficient to furnish a woollen garment to every inhabitant of Europe. The gold production, on the other hand, after attaining the quite surprising dimensions of 10 to 13 millions value for some years from 1851, has gradually fallen off since to only about half that amount. Cereal production is already conspicuous in Australasia, at least in the favourable seasons of a climate somewhat uncertain for this industry. In 1879, for instance, the young and still comparatively small colony of South Australia had 400,000 tons of wheat to spare for export. New Zealand has entered upon agriculture and wheat growing upon farms of colossal dimensions, with all the aids of the most advanced machinery. But already it is said that the like advanced farming at Manitoba, on farms of the dimensions of an English county, must extinguish the rising Australian prospects, on account of the greater proximity to this country. I do not, however, expect this result. The effect of a still considerable gold export in reducing homeward freights is in favour of our remoter producers. One of the earliest and most conspicuous effects of the gold discoveries in Australia was a fall to one-half in previous homeward freight rates, because the return cargo for a thousand great ships, with capacious holds full of ordinary merchandise, was only a few cubic feet of gold.

India our Chief Customer.

Our foremost figure in colonial commerce has of course been India. For the last ten years her average imports of merchandise have been 34 millions, and exports 58 millions. Of the latter about one-half comes to this country. One remarkable feature of Indian trade is the great excess in importation of treasure, chiefly silver, as compared with exportation, the respective totals for those ten years having been 91 millions and 22 millions. Besides the raw cotton already alluded to, her great opium export is only too notorious. That, however, is directed to China. It amounts in value to no less that one-fifth of the whole yearly merchandise export trade. The article jute, so useful for all rough sacking, has advanced, from less than a million sterling twenty years ago, to upwards of three millions now. Indigo is now exported to the same annual amount. There are considerable amounts of rape and linseed, rice and sugar, and already the new export article tea is up to three millions of yearly value. India, in short, with her vast population, her sixty millions of revenue, and already nearly one hundred millions of merchandise trade, gives the largest figures of our outside empire. Largely exceeding the parent in population, she makes no distant approach in amount of revenue. But India, as before remarked, is not in the proper sense a colony. The comparative vigour of progress in the true colony is well illustrated in the striking fact that already the united Australasian group has a total of trade almost equal to that of India.

III.—COMMERCIAL PRINCIPLES AND PRACTICE, AND TARIFF RELATIONS, AS BETWEEN THE MOTHER COUNTRY AND COLONIES.

Retrospective Glance.

We shall not readily or fully understand the very interesting and important but somewhat complex problem of the present tariff relations of

our vast and diversified empire, unless we take a considerable retrospective glance. Our colonial empire of a century past, such little as there was of it then, has altered and advanced politically as strikingly as in any of its other features. Prior to the American disruption, a British minister could declare in Parliament that a colony had no right to manufacture for itself even a nail to a horse shoe. Protection to and protection from was the reciprocal rule, until we at home expanded our views into that free trade which has been our rule of commercial government for the last thirty-five years.

The Differential Duties Act of 1850.

What still regulates fundamentally the colonial tariff system is the Imperial law of 13 and 14 Vict., commonly known as "The Differential Duties Act," but which in fact is only the section of an Imperial Act of that date for the better government of the Australian colonies. In introducing this most important measure, Lord John Russell explained that, having the previous year put an end to monoply by repealing the Navigation laws, this would put colonial as well as home tariffs on the broad free basis. The main object of the Act was to check reciprocity or protective arrangements by prohibiting differential duties. Each colony was to admit at the same duty the same kind of import from whencesoever arriving.

Colonial discussions and contention over the tariff restrictions of this Act have been ceaseless ever since, and have resulted in some modifications which I will briefly point out. In conceding constitutional self-government to the more advanced and independent colonies, the Home Government has practically allowed to each separate Colonial Government the control of its own tariff. Each colony might thus protect its own producers, but could not, in face of the Act alluded to, engage in protection or reciprocity outside, even to adjacent sister colonies.

Modifications of the Act—as to Canada.

The first vigorous movement towards a freer colonial tariff came from Canada. The tariff question was indeed a chief consideration in that other movement which in 1867 resulted so successfully in establishing the great union of British North American colonies now known as the Canadian Dominion. The Canadians complained that they were unfairly exposed, along their whole frontier line, to the closely protective system of the United States, which could flood Canada with goods by aid of our own Differential Duties Act, and yet refuse all Canadian goods in exchange. But now, by union under the one Dominion Government, the various associated colonies can interact with the freedom permitted previously to a separate colony.

As to Australia.

On this fertile tariff question, the Australian colonies were promptly in the wake of the Canadian. They claimed a good deal more, and argued stoutly for complete intercolonial liberty, and in some cases for even that of direct tariff arrangements with foreign States. The Home Government, while rejecting these views, the tendency of which, as was properly remarked, must be to break up the empire, is favourable, or, rather, would not be opposed to Customs unions, or still more complete political union, between adjacent colonies, so as to give the intercolonial tariff the freedom conferred upon Canada. The Australian colonies had already strongly felt the convenience or necessity of some such union, as, for instance, in the border-duty difficulties along the River Murray between New South Wales and Victoria.

Amended Tariff Act, 1873.

In fine, there were two elaborate and able despatches on the whole question from the then Colonial Secretary, Lord Kimberley, dated respectively 13th July, 1871, and 19th April, 1872; and these, after due response from the colonial side, resulted in the amended Imperial Act of 26th May, 1873, which seems to have closed legislation for the present upon the intercolonial tariff question. Although this is only an Act ostensibly "with respect to Custom duties in the Australian colonies," yet, with the usual understanding in such cases, it is applicable to all like conditioned colonies. By this Act, these Australian colonies, or any two of them, are free to make tariff reciprocity arrangements as they please, provided 1st, that, as regards other countries than themselves the Differential Duties Act of 1850 still applies; and, 2nd, that there be no contravention of existing imperial treaties. From these data it may be inferred that, certainly, the separate colonies of any colonial group, and possibly any separate colonies whatever, may make intertariff arrangements to the exclusion of the mother country as well as all other places, countries, or colonies outside of themselves. Indeed, the Act of 1873, still standing as it does upon that of 1850, requires this most odd-looking proscription, unseemly as it must appear towards the mother country as well as others of the family.

Importance of the Tariff Question.

The whole tariff question is most important to the empire's future. It is sure to be constantly raised with reference to the diversified and conflicting tariff views of our colonies. Indeed, there is at this very time sitting in London a great Tariff Congress, summoned by the Canadian mercantile interest, and representative of the commerce of the whole empire, the avowed aim of which is the promotion of some reciprocity arrangement for the empire. In one of his despatches, Lord Kimberley remarks that if all the colonies would but follow the free-trade principles now so long acted upon, and with such decided advantage, by this country, all tariff difficulties would disappear. But, unfortunately, all the colonies do not see the matter. Most of them, indeed, have thrown in their lot with their mother's free-trade system; or in the younger cases, such as that of the Australian colonies, have chiefly continued the free system implanted by imperial influence at their commencement; but others, and more especially the great Canadian Dominion, and Victoria in Australia, have relapsed into protection or reciprocity, on a variety of reasons or excuses.

On the subject of this colonial tariff question, we have a recent Parliamentary Return for last year (Foreign and Colonial Import Duties, Parts 1

and 2, H.C. No. 120 of 1880), showing the rates of duty levied in our principal colonies upon leading articles of importation. These have, in no small number of instances, a protective character, more especially in the case of the Canadian Dominion; although at the same time, as the report justly notices, the duties of this character are in general quite moderate as compared with those of some foreign countries, of which a table is also given for purposes of comparison in the report. Thus while a few rates upon certain manufactures are as high as 20 to 30 per cent. in the Canadas and some few others of the colonies, in the United States and other foreign countries, they are 50 per cent., and even 100 per cent. *ad valorem* and upwards.

That protection means economic or material loss, as compared with the free direction of labour, is in most cases readily admitted. But it is contended by our colonial protectionists that social or political considerations are of prior consideration to the merely economic. Unquestionably they are. At the same time, as our country from the free-trade standpoint would urge, if the economic disadvantage be a real fact, there ought not to be any protective interference with free commercial action, except for very clearly demonstrable social or political necessity. We may, I think, fairly assert that our country's experience has been to the effect that all the general interests of a people have ever their best chance under the fullest free-trade resources.

IV.—Some Concluding Reflections.

Differences and Resemblances of other Empires to ours.

There are three great and somewhat similar empires in the world, namely, that of Russia, that of the United States of America, and that of our own people. There are of course other countries, not a few, claiming to be empires. But these three have some special resemblance alike in their colonising aspects, and in the problems they have to deal with in the government of remote and more or less separate societies. With certain resemblances in all three, there is one most important difference between our empire and the others. While the latter have retained effective political control to the furthest extremities respectively of their great areas, our Imperial Government has practically, to a very large extent, given up that control, in successive concession to the demands of the vigorously progressive self-supporting and self-governing societies which we have so successfully planted in almost every great region of the world. This question has a direct connection with the subject of my paper; for colonial tariff differences, and the eagerness with which each colony seems instinctively to contend for complete tariff license, are together, perhaps, the very chiefest cause of this segregative action. The whole case, in its aspects alike political and commercial, forms that "colonial question" which, in view of our future hold upon the British nationality spread over our grand domain, has been gradually rising upon us here at home during the last dozen of years, but which I must not further enter upon in the restricted limits of this paper.

The Colonial Question that "Trade follows the Flag."

But keeping strictly to the commercial part of the question, there is one section of it on which I may still offer a few remarks. We are all familiar with the phrase that "Trade follows the Flag;" and perhaps we are equally familar with the counter assertion of what is called "the Manchester school," that trade has no such partiality or nationality, and follows no flag in particular, except that of its own interests. The difference of view here is due to what makes differences in so many cases, namely, the pursuit of an abstract or deductive reasoning, without regarding the frictional surroundings of the facts of real life. The expatriated colonist, who turns his eyes back to his old home, and methodically, and as of course, sends his goods to that market, and orders his requirements out of it, is perfectly convinced that as a matter of fact, all theories notwithstanding, trade does follow the flag.

The reconciling explanation is really much simpler than most people who enter upon the question are accustomed to imagine. There is nothing more in the flag doctrine than simply the differences or difficulties of a foreign as compared with one's own nationality. There are three main obstacles in the path of foreign commerce, from which our own commerce—home or colonial—is free. First, there is the foreign element in its comparatively repellent effect; second, the different speech; and third, the different moneys and weights and measures. The whole constitute a natural "protection," tending, even for successive generations, to bring the bulk of a colony's commerce into the parental market rather than any other.

A very simple and direct illustration of the flag doctrine is supplied by the school boy who, penny in hand, is confronted for his custom by two competing applewomen. If these old ladies were exactly a match in themselves and their appurtenances, the smallest possible difference—the direction of the wind, or the matter of a half inch of distance—might suffice to determine his preference. But suppose one of the women to be a foreigner. Suppose, again, that she was unable to speak the boy's own language. Even if he had no further botheration about her foreign weights and money, he might be persuaded into accepting even the smaller apple of the two from his own countrywoman.

No doubt the "flag" effect has its limits. It may stand good at 1 per cent., and be overborne at 2 per cent. of difference. But in these days of industrial efficiency and close competition, some such small difference as the 1 per cent. may involve the whole, or nearly the whole, case. We see this remarkably exemplified, year after year, in the fact that almost every bale of our vast colonial wool clip is sent to and sold in this country, although often one-half, or even considerably more, of what is dealt with at the great London wool sales, is immediately re-exported to other countries. I cannot, therefore, agree with those, and they are still a large, although, as I am happy to think, a diminishing number, who hold that is of little consequence, commercially considered, whether or not our colonies

remain part of us. Mr. Goldwin Smith, amongst others, has told us that "Free trade wants no colonies. It can be carried on as well, if not better, with nations that are independent, as with those which have a political connection with Great Britain." All this, I reply, is only a further instance of that abstract reasoning already alluded to which overlooks experience and the facts of life.

The Imports and Exports Question—Problem of excess Imports.

Let me turn to quite another subject. Much importance has been attached to the remarkable preponderance, especially in late years, of our home import over our home export commerce. If we examine our colonial returns, and those of new offshoots generally, there is commonly excess the other way, at least after that first stage of their life during which such countries or colonies are supplied largely from outside, until they have organised their own labour. It is important to bear in mind this fact as regards onr colonies, because it helps to explain the quite opposite feature of our home commerce.

I return to Mr. Bourne, who has given an unusually full and accurate explanation of a feature simple enough when thus explained, but which has puzzled and even alarmed many who had less mastery of the subject. Taking, for instance, the 20 years from 1857, the average yearly excess of net imports over net exports (that is, of imports retained for consumption, and of exports of our own produce) was about 60 millions. Mr. Bourne then explains that about one-half of this apparent excess is due to mere omissions in the method of our official reckoning, as, for example, when we omit from exports the ships and steamers we are constantly supplying to outside buyers, all of which vessels, with their stores, more especially of coal, are as real exports as anything else, and make up collectively a large yearly item. Again, there must be excess imports from wear and tear, and increasing use in the arts. And yet again, from the recorded import values we must deduct the cost of bringing the imports, a cost which of itself a careful estimate has made as much as 11 per cent.

Thus the 60 millions excess imports are reduced to about 30. But these 30 millions also entirely disappear when Mr. Bourne finds, on a balance of estimates, quite that amount to be due to us yearly as interest or dividends on colonial or foreign loans, or other outside investments. If this has not been quite 30 millions for the whole twenty years in question, there remains yet a very great deal more to be counted in the same direction. First, there are the drawings on India, which latterly average 15 millions yearly. Second, the profits of the import and export trading, as well as the freight earnings of our shipping. Third, and lastly, the earnings of our people abroad, remitted to be spent or invested here. All these credits to us must be paid in imports, and, as Mr. Bourne in effect remarks, so completely do they turn the scale, as to leave to be accounted for, not a great excess of imports, but, on the contrary, no inconsiderable excess of exports, which, as he properly adds, must still swell the outside indebtedness to this country.

The further and complete explanation, as it appears to me, is found in a direction usually quite overlooked. It is due to the increase of our export account by the payment of the loans or other advances we are so constantly making to colonies, countries, or other parties outside. Mr. Bourne, in short, has shown that the real problem is not an unaccountable excess of imports, but rather an unaccountable excess of exports. The export excess, as I would add, finds its solution in a due allowance for our outside loans or other advances, all of which must eventually be paid or balanced by exports.

Thus we can better understand the great export excess of our trading returns during our heavy war payments in the earlier part of this century. Mr. Bourne, by an estimated correction of official to real values, finds that in the year 1816, for instance, our net imports were only 17 millions as against no less, comparatively speaking, than 41 millions of net exports. This export excess, he goes on to say, appears to have gradually abated till about 1825, when the modern feature of this uniform excess of imports began.

These considerations help us to deal with the very remarkable figures of excess imports in our home trade returns for the last few years. For the ten years, 1871-80, the average yearly import excess has risen from Mr. Bourne's rather earlier average of 60 millions to 99 millions; and for the latter half of that term, namely, the five years, 1876-80, the average yearly import excess is no less than 137 millions. There is also the additional feature, so unfavourable by rule or rote to a certain class of alarmists, of a decided falling off in exports, along with decided increase of imports. As the returns in this way are in fact quite exceptionally remarkable, allow me to present them more in detail. Our exports appear to have culminated in 1872, when they reached a total of 315 millions. For that year the total imports were 355 millions. For the eight succeeding years the exports steadily decline, until for 1880 they are only 223 millions; while on the other hand the imports keep increasing, until in 1880 they reach the unprecedented total of 410 millions. How is this problem to be dealt with?

Explanatory Considerations.

I utterly reject the dolorous explanation freely indulged in, that, in such increased imports and reduced exports, we are devouring our capital instead of our income, and are besides being successively more and more expelled from outside markets by too successful foreign rivalry. The facts of our business life, present as well as past, are entirely opposed to both these conclusions. Certainly there has been no such change in our spending habits during these last eight years as to make us now utterly disregard the limitation of our earnings. On the contrary, our economists still calculate, on sound data, the many millions of the annual savings of the country; and our income-tax returns are standing proofs in the same direction. No doubt our distinguished Premier, in his Budget speech last month, laments that the income-tax, which had rolled up with steady and huge steps from £750,000 a quarter of century ago, to £1,990,000 for each penny of levy for the years 1877-8, should, three years later,

have to be estimated at only £1,943,000. Well, so be it. But the smaller amount is hardly one whit less effective than the larger in overturning our alarmists' views. By way of accounting for this slight check and reaction, most of us may still recollect some exposures of hollow trading towards the end of 1878, the most prominent instance of which was the notorious City of Glasgow Bank.

Well, we are left to explain, in some other and happier way, the features in question. I have already alluded to a comparatively unnoticed feature—the increase due to our exports from our making, from time to time, great outside payments. I have now to notice a feature just the opposite, and almost equally overlooked, namely, the effect upon our imports of any great repayments of such principal sums. We have been receiving largely such repayments of late, in particular from the United States; while further, as all tending to the same effect, namely, that of increasing our imports and reducing our exports, both France and the States are beginning to compete with us in supplying the poorer outside world with capital.

The United States, as is well known, have been making most strenuous and exemplary efforts to reduce or extinguish the great public debt bequeathed to them by their civil war, and this has been especially the case during the last two or three years. Great part, probably the greater part, of these repayments, have come to this country. As bearing me out in the general view which I have been presenting, let me give the later import and export figures of the States. In 1877 the imports are 98 millions as against exports 122 millions; for 1878 they are respectively 86 millions, and no less than 145 millions; for 1879, 103 millions and 151 millions; and for 1880 respectively, 139 and 178 millions. These are very startling figures, equally so, indeed, with our own in the exactly opposite direction; but both series are equally explicable on the principles I have endeavoured to lay down. They are not necessarily the indication respectively of either great profit to the one country or great loss to the other. If we have received of late unusually great payments, thereby swelling our import figures; and if we have used these largely to improve our home estate, instead of sending them again abroad, thereby tending to comparatively reduce our exports, we may not, by such occasional variety in our economic procedure, be promoting less than at other times the general well-being.

The Future as to Mother Country and Colonies, and its Feature of Accelerating Progress.

I have now but a few words, in conclusion, upon that feature of our progress, or more properly of our accelerating progress, which I have already repeatedly referred to. Dr. Benjamin Franklin, on hearing of instances of long suspended life in insects, expressed the wish that his own life could be thus suspended for a hundred years, in order that he might see the expected great progress of his country. That hundred years has just passed; and if the patriot philosopher could now return to see all the advance of his great country, it would probably far surpass even his most sanguine anticipations. Again, it stands recorded of our postal service, and the record is so little removed from us as to be found within the preceding century, that the mail from Edinburgh to London conveyed, on one occasion, but one letter. What would a Franklin *redivivus* of those small postal times say now, or how could he possibly have anticipated the aspects and dimensions of a modern mail between the two capitals!

If we are to judge by the past, and more especially the recent past, the waking up to a further century of progress would present a vast advance, as well as a marvellous change of aspect, as compared with even the present great attainments of our empire. If the empire is still, as we all hope and wish, to hold together, and this, with due care and precaution, where all parties are so agreed, ought not to be impossible, we may expect that even the short space of a century might produce incalculable changes. Prior to the present age, a century did not very much alter any part of the world, even if our comparison include the best and most progressive days of ancient Rome and Greece. But in a further hundred years, at the apparently geometric acceleration of pace upon which we have entered, what may be the aspects and progress, for example, of the great Canadian Dominion, of the almost boundless expanse open to the Cape Settlements, and, more perhaps than all others, what the advance and change of the Australian colonies?

The mother country's progress may continue the marvel we have just alluded to in her postal business; but she will certainly be far surpassed by the relatively quicker progress of most of her colonial children. In the *Statistical Journal* of last year (1880, pp. 491-4), Mr. Price Williams has given us some curious results of the estimated future population of this country. Going much beyond a mere hundred years, he finds limiting causes which will prevent Great Britain, for instance, with its present 29 millions, having more, as far on as A.D. 2231, than 132 millions; or upon another and more hopeful calculation, 176 millions for the year 2181, or three centuries hence; while London in the same time is to rise from 3,700,000 to only a little over nine millions. My own idea would be to extend very greatly this calculation, even for our parent State; for in these days of enterprise and progress people will be born into the world, and once there they will contrive to keep themselves alive and comfortable by aid of all the science and the business facilities and resource of their day, and they will again quit the world only to leave families of still greater numbers behind them. But in any case our colonies' progress is not restrained by any of the narrower circumstances that may be supposed to tell against their common parent. Those of us today who, as Franklin did last century, enjoy a mental excursion into the future, have there a free domain before them, and an assurance that they can hardly be too sanguine in their expectations and estimates. Let us hope that our great grandchildren, who are actually to realise all our present guesses, will still look upon a united British Empire, which is destined rather to be held more firmly together, than to be disunited into fragments, by the accumulating weight of its great future attainments.

DISCUSSION.

Mr. Stephen Bourne said this subject was one of immense importance, and he believed it would grow until it forced itself on the attention of economists and statesmen to an extent at present not dreamed of. The progress of other nations, as well as our own, was a point which required to be borne in mind, for there was no doubt that both France and the United States were increasing in the amount of their trade more rapidly than we were. This was not a thing to be mourned over, for if we believed that trade was good for us it was good for the rest of the world, and we could not be surprised at younger nations overtaking us, and by their own progress adding to the general welfare. At the same time it was very important that we should not go backward or neglect opportunities for further progress. He quite endorsed what was said in the paper as to the contrast between official and real values, and was glad to think that the allusion to the subject would lead statisticians and economists to see the danger of contrasting the figures of the present day with those of many years back, without understanding the difference between them. If one took the price of bread or meat in the time of Queen Elizabeth, and compared it with present prices, it would show how fallacious a comparison founded on money value must be, if uncorrected by the quantity of the article referred to. If this were not attended to, statistics, as had been said, might be made to prove anything, whereas, if treated honestly, and with due information, they were most valuable. He thought Mr. Westgarth had rather underestimated the amount of our colonial as compared with our foreign trade. The fact was our colonial trade, both export and import, had been growing more rapidly than our foreign trade. This was a satisfactory feature, because it was of very great importance to keep up our trade with those allied to us, and it showed the advantage of our efforts in aid of colonisation. It was quite certain that trade to a great extent followed the flag, but he did not attribute this altogether to attachment to the flag. No doubt that had an influence, but in addition to that a colonist had greater credit in his native country than elsewhere, and colonial trade grew up principally on credit. But whatever the truth might be, the fact formed a very good reason for endeavouring to promote emigration to our own colonies rather than to the United States. A friend of his in those States recently suggested to him that it would be a good speculation to invest in some of the land companies there, and no doubt money was to be made in that way, but whatever his ideas of the wisdom of such an investment might be, he could not consistently assist emigration to the United States in preference to our own colonies, whilst the former acted in such a hostile manner towards us in respect to the tariff. Canada was now doing something of the same kind, but he hoped she would soon see the wisdom of making a change. He could not recommend anyone to emigrate to a colony which did not establish perfect free trade between herself and us. He had some later figures than those quoted by Mr. Westgarth, showing that in 1880, out of a total trade in cottons, woollens, and iron goods, to the amount of 223 millions, 124 millions were with the colonies. That being so, one could readily understand how any depression in those three great branches of trade was felt so extensively throughout the whole country. It was impossible to over-rate the importance of the tariff question, and his decided opinion was that the true solution was only to be found in the mother country and all her colonies having one uniform tariff, both for customs and excise duties. The man who took his drink of brandy in Norfolk paid the same amount to the revenue as the one who drank brandy in Middlesex; and he held that the man in Canada, or Australia, should do the same. If the colonies required to raise a larger revenue, they should do so in some other way. That would be a better system than to endeavour to persuade the mother country to allow the colonies to impose protective duties against herself and all the world besides. However much clamour might be raised in support of such a scheme, he did not believe Englishmen would ever retrace their steps in the matter of free trade, and he was quite sure that if they did, such action would soon give the death-blow to English commerce. With regard to the vexed question of imports and exports, Mr. Westgarth had correctly stated the gist of the question, as he had himself laid it down some years ago, in a paper read before the Statistical Society. There could be no doubt that the average excess of 30 millions of imports over exports was reducible to about 30 millions, and it was fully accounted for by the receipts which we had from our investments abroad, and the freights earned by our ships in carrying the goods. But the object of the paper from which these particulars had been extracted, was to show that although that had been the state of things in times past, it was now entirely altered. In the earlier history of our commerce we exported largely in excess of our imports, and though no doubt the maxim of Adam Smith, that whatever a country imported must be paid for by her exports, was true, it was true only over a long series of years; it did not follow that it was true in every year, or that circumstances might not be changed. His object in that paper was to point out that when we had a preponderance of exports we were not impoverished, because we were making loans to the colonies and foreign countries. For instance, when the United States was developing her railway system, we supplied her largely with railway iron, but we took payment in American bonds and securities; and hence we were exporting largely without any apparent return; we were making America our debtor, and held a mortgage on her property. At that time we were growing nearly all the food we needed, but now we grew much less than we required; America was supplying us largely, and we were paying her, unfortunately, not with our exports, but by writing off her obligations to us. He had no doubt whatever, that for a series of years England had been rating up her capital to the extent of 50 millions a year, and America had been paying off her debt by the food she had been sending us. The drain of gold which some people talked about would not set in until America had exhausted all her bonds and other securities which were held in this country, but when that was done, if the present state of things continued, we should be drained of our gold to pay for the food we required. That was the view he expressed some seven years ago, and he had seen no reason to alter his opinion since. At the same time he did not take a dolorous view of the matter. The result depended on the wisdom with which we acted. If a man with a large family, who found it difficult to find bread and butter for them all, allowed them to grow up in idleness, or spending their time in painting pictures, or adorning the garden, instead of earning money, he should tell him he was doing wrong—spending his capital—and that the only result could be bankruptcy. And it was just the same with a country; if we went on spending more than we were earning, there could be but one end. The large excess of imports had been almost entirely in articles of food; and if that food were turned into human muscle, to be employed in manufacturing goods for export to pay for it, he did not care how much food was imported; but if, on the other hand, the labour the food supported, either could not find employment, or was devoted to unproductive purposes, we were living too fast. What we wanted was to increase our trade, and if foreign countries were ceasing to buy of us, we had a grand resource in our colonies. Every economical consideration showed that we ought by every means to stimulate emigration to our colonies, thereby saving the lives which we were destroying by

overcrowding and unsanitary arrangements, and at the same time raising up customers, and enlarging our own market.

Mr. Bridgewater said Mr. Bourne's conclusion seemed to be that unlimited free trade would be a very good thing if only we had a condition of things which was not likely to occur. He congratulated Mr. Westgarth on his paper, which some years ago would, no doubt, have been exceedingly satisfactory, but, at the present time, there were many things which tended to show that free trade was not such a universal panacea as it had been represented. It appeared from the paper that America was improving in her commercial prosperity, simultaneously with England's decline, and the question was whether America was right or England. It was a very curious thing that the two greatest Republics in the world altogether refused to adopt the teaching of the Manchester School, and went in for protection. They were both flourishing, but in England, Consols were above par, land was greatly reduced in value, and farmers were all complaining that they had lost their capital. Practically, the money was being drained out of the country. Working men had cheap food, but they had low wages, and they were beginning to see that it was better to have the loaf at 1s. with money to buy it than at 6d. if they had no money. The question was not by any means so clear as it was represented, and it was very doubtful whether an exactly opposite system ought not to be adopted.

The Chairman said he hoped succeeding speakers would not go further into the subject of free trade, but keep to the subject of the paper.

Mr. William Botly said he would attend to the Chairman's request, although he had never heard views more fallacious or opposed to common sense than those propounded by the last speaker. The paper was a most admirable one, and it was very important to remember what good customers for our manufacturers we had in our colonies. Only a day or two since, he saw a statement from Melbourne to the effect that the total exports from Melbourne, Adelaide, and Sidney, for the past month to Great Britain had been :—Wool, 15,000 bales; tallow, 4,800 casks; copper, 900 tons; copper ore, 900 tons; wheat, 53,000 qrs.; flour, 75,000 tons; tin, 22,000 ingots. He had as much correspondence with the colonies as most people, and the letters he had received within the last few days, fully corroborated the views of Mr. Bourne. In Canada there was a great field for agriculturists, if these had skill, capital, and enterprise, but helpless waifs and strays who would be a burden on any country were not wanted. It would be impossible for England to do without free trade, and, though he was a small landowner himself, he should say that if landowners demanded protection for the sake of increasing their rents, they ought to be all driven into the sea.

Mr. Edgecombe said it had been clearly shown that other countries which had not followed England's free trade policy, had made more rapid progress. At the present moment, England had the whole world against her with hostile tariffs, and the question was where was she in future to obtain a trade, by which to pay for the food which she required. It appeared to him that we ought so to legislate as to induce our children to migrate from the home country to the colonies, so that British land, under the British flag, might send the corn required, and that we in return might find our commerce increase. He could not agree with Mr. Bourne, that a uniform tariff for Great Britain and all her colonies ought to be insisted on; there might very well be differential duties in some colonies which required to raise more revenue for their own purposes. Everyone would agree that our trade with the colonies should be fostered and protected as far as possible.

Mr. Clements said he had never listened to a paper which had given him more satisfaction than the present. He thought all countries should have perfect liberty to adopt any fiscal system they pleased. This country had obtained considerable advantages by free trade, but these had not been unqualified advantages, and concurrently with its introduction had come the development of the railway system, and other matters which were great factors in the increase of English commerce. The excess of imports was, no doubt, due to the increase of population, being principally in articles of food, the English farmer not being able to compete with the American in the growth of corn. He thought English farmers should turn their attention to other kinds of produce, such as milk and vegetables, which would pay them better.

Mr. Cook said he would not now speak of free trade, but he thought that at some other time it might very usefully be discussed. He should like to know, when it was said that the excess of imports consisted of payments for investments in foreign countries, whether it was merely the interest we were receiving, or the capital; if the latter, what was done with it? If we were paying for our food with it, we were certainly living on our capital.

Mr. Trelawney Saunders could not miss the opportunity of impressing on the public the importance of the colonies to this country, and of this country to the colonies. With regard to the doctrine of the flag, he could not imagine a stronger instance than the trade we did with the United States—people of our own race and language; in consequence of this question of the flag, we exported less there than to Australia, although the population was twenty times as large. The colonies were necessary to this country if we were to rely on our own soil for our food. Without enlarging upon the vexed question of free trade, he would venture to remind the gentlemen who spoke so despairingly of the present condition of things, that within his own memory there was not a farmhouse where the men did not eat barley bread; now such a thing was unknown, and the conditions of society had improved in like manner throughout. A remark had been made that they must be careful in all their discussions to avoid politics, and he quite agreed that they should not go into party politics; but until a question became one of party it ought to be open to them, and it was impossible to consider colonial questions without looking at their political aspects. The question of tariffs could only be settled on the basis of common legislation at present, because the colonies were not represented. Until that was done, it was no use talking about intercolonial or international tariffs. He hoped some opportunity would be given, either in that Society or elsewhere, to consider the manner in which a union of the colonies and the mother country could be brought about. It was a question which could not be allowed to slide, for every day personal interests were growing up which constituted obstacles in the way of union. The only centre from which union could be brought about was the mother country, because Australia and Canada would not of themselves see any necessity or advantage in being united with each other. The colonies owed their existence and protection to us, and he thought they would be willing to take their fair share of the burden and responsibility. He felt sure that a severance of the colonies from the mother country would have the same effect as the breaking up of the old Greek republics; we should simply become the prey of the common enemy.

The Chairman said they would all agree in the importance of the colonies to the mother country. It was the rule here not to go into political questions; but, as had been said, it was quite impossible to deal with such a question as the colonies altogether apart from it. He begged to propose a cordial vote of thanks to Mr. Westgarth for his extremely interesting and valuable paper

The vote of thanks having been carried unanimously,

Mr. Westgarth, in reply, said time would not admit of going at length into the many questions that had been raised; but he thought Mr. Bridgewater, like Mr. Ruskin, regretted these times of hurry and progress, and would like to go back to the old sylvan days, when everybody sat quietly under his own fig-tree. He would only say to him, that one of the favourite arguments of Protectionists was, that in England wages were so high, that the manufacturer in this country required protection against lower wages elsewhere.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 11th, 1881; Lieut.-Colonel DONNELLY, R.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Betts, Edward Peto, M.A., The Holmwood, Bickley, Kent.
Clark, Robert Ingham, West Ham Abbey, Stratford, E.
Cottrell, James Maskall, 340, Brixton-road, S.W.
Glover, William, Tower Chemical Works, Victoria Docks, E.
Grant-Duff, Malcolm, Imperial-chambers, Bowlalley-lane, Hull.
Treloar, William Purdie, 69, Ludgate-hill, E.C.

The following candidates were balloted for, and duly elected members of the Society:—

Allison, Herbert John, 41, Southampton-buildings, Holborn, W.C.
Baggallay, Henry Charles, 4, Ada's-avenue, Hull, Yorkshire.
Blakesley, John Holmes, M.A., 23, Fopstone-road, South Kensington, S.W.
Elliott, William St. George, M.D., 39, Upper Brook-street, W.
Favarger, Henri, 75, Turnmill-street, E.C.
Heseltine, Francis J., Westminster Palace Hotel, Victoria-street, S.W.
Inglefield, Admiral Sir Edward, K.C.B., 99, Queen's-gate, South Kensington, S.W.
Keefe, John, Colquitt-chambers, 6, Colquitt-street, Liverpool.
Longworth, William, Guildford, Surrey.
Matthay, George, F.R.S., Cheyne-house, Chelsea Embankment, S.W.
Ramsden, John Carter, Gristhorpe-hall, near Filey, Yorkshire.
Ravensworth, Earl of, 9, Mansfield-street, W.
Severn, Walter, 9, Earl's-court-square, S.W.
Snape, William, J.P. (Mayor of Over Darwen), Lynwood, Darwen, Lancashire.
Sproston, Hugh, Hughville, South Norwood, S.E., and Demerara.
Thornton, Edward, C.B. Bank-house, Windsor.
Warren, W. J., Cotford-villa, Bournemouth.

The paper read was—

THE MANUFACTURE OF GLASS FOR DECORATIVE PURPOSES.

By H. J. Powell, B.A.

"The manufacture of glass for decorative purposes" is a subject of considerable extent, and requires more time to do justice to it than is at present available. The subject may conveniently be divided into three parts:—1. The development for decorative purposes of the natural properties of glass; 2. The production of decorative forms, or decorative material, by the manipulation of glass in a plastic or viscous condition; 3. The treatment of the surface of glass with a view to supplement the effects due to its form or its nature.

I.—NATURE OF GLASS.

Glass is defined as an amorphous transparent solid, and the existence of devitrified glass, which is both crystalline and opaque, and of other opaque glasses to which I hope to allude, need not materially damage this definition. There are many different glasses, but all agree in being built up of compounds which are called silicates, a silicate being formed by the union of the oxide of silicon, or silica, with another oxide. The large family of silicates may be divided into two groups, the one being composed of alkaline, and the other of the metallic silicates. It is only necessary to mention a few individuals belonging to each of these groups, namely, those of the first group, which respectively contain the oxide of potassium and the oxide of sodium, and those of the second, which contains the oxide of lead, the oxide of calcium, and the oxide of barium. Every glass must contain at least one silicate belonging to the group of alkaline silicates, as well as one silicate belonging to the group of metallic silicates. Manufacturers have practically nothing to do with silicates as silicates, but knowing that the nature of a glass depends upon the natures of its constituent silicates, they put into their crucibles materials of such a nature, and in such quantities, as will produce the silicates, and consequently the glass which they require. The raw materials are, as a rule, oxides or carbonates; a carbonate being a compound of an oxide with the oxide of carbon or carbonic acid. The most important materials are sand (an impure form of oxide of silicon), red lead (a mixture of the oxides of lead), and the carbonates of potassium, sodium, barium, and calcium. The whiteness of the resultant glass depends upon the purity of the raw materials, and especially upon the absence of iron, whether as an oxide or as a metal. The silicate of lead is formed by the direct combination in the crucible, under the influence of intense heat, of sand with the oxide of lead. The silicates of potassium, sodium, barium, and calcium, are also formed in the crucible by the indirect action of the sand upon the respective carbonates. This indirect action consists in the expulsion of carbonic acid gas from the carbonate by the intensely heated oxide of silicon, and the consequent union of the latter with the residual oxide. Given the alkaline and metallic silicates required to form a certain glass, the necessary raw materials for the required silicates are simultaneously thrown into the crucible, and the silicates will be simultaneously produced by the action of the heat of the furnace in which the crucible has previously been "set."

The simplest form of a glass furnace is a circular base, covered by a flattened dome. In the centre of the base is a comparatively small grate, and round the grate, under arches formed in the wall of the dome, the crucibles are placed. Flues pass through the dome at the side of each arch, which direct upon the crucibles the heat and flame re-

flected from the centre of the dome. The arches serve for the introduction and removal of crucibles as well as for the removal of glass from the crucibles, when required for manipulation. Crucibles are built of fire-clay roll by roll, and their shapes are regulated according to the nature of the mixtures which they are intended to hold. If the mixture for a glass contains oxide of lead, it must be protected from the reducing action of flame, and the crucible must be closed on all sides, except where no flame can reach. Mixtures containing no oxide of lead are exposed in large open fire-clay bowls to the full action of the flame and heat of the furnace.

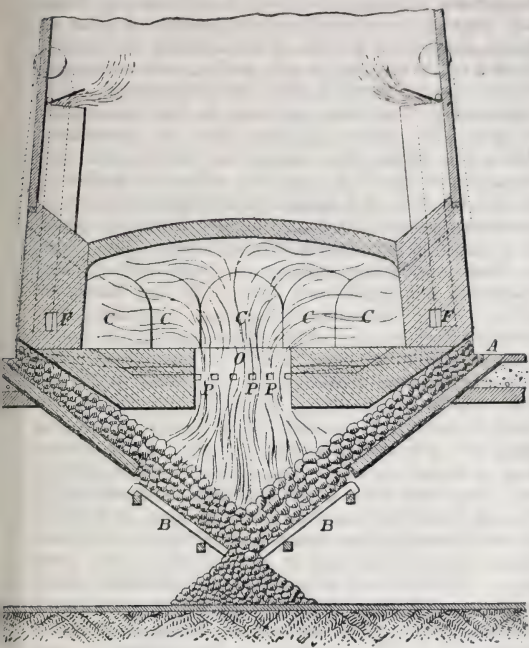

FIG. 1.—FURNACE.*

Different glasses possess different qualities, according to the number and nature of their constituent silicates. As a general rule, a glass containing two silicates is less fusible, but considerably purer in colour and texture, than one containing a larger number. A homogeneous glass is more easily obtained when its constituent silicates are of similar or approximate specific gravity. Plate and sheet glass, composed of the silicates of sodium and calcium, are generally homogeneous, but possess a green tinge, due to the silicate of sodium. Crown glass is white, owing to the replacement of the sodic silicate by silicate of potassium. Flint glass, consisting of the silicate of lead and silicate of potassium is both white and brilliant. The brilliancy of flint glass is due to the density of the lead silicate, but this very density is frequently the cause of striæ and irregularities in the substance of the glass. It is almost as difficult to obtain a clear mixture with the silicates of lead and potassium, as with water and oil. The silicate of barium is used for pressed glass, as a cheap substitute for the silicate of lead. Venetian glass contains three silicates—namely, those of sodium, calcium, and potassium, it is therefore fusible, and its density is trifling. To these two properties the lightness and intricacy of Venetian work are to be attributed. Venetian glass is generally devoid of brilliancy, and very far from being either white or homogeneous, but these very deficiencies give that horny effect which is looked upon as a characteristic beauty.

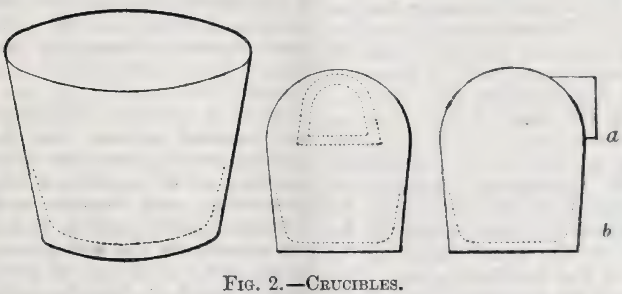

FIG. 2.—CRUCIBLES.

Bohemian glass, in addition to the silicates of sodium, potassium, and calcium, contains traces of the silicates of magnesium and aluminium. It is fusible, easily manipulated, and developes, with the sub-oxide of copper, a ruby colour, which cannot be attained with a glass containing silicate of lead.

When fusion and purification are complete, the glass in the crucible is in a condition closely resembling that of very glutinous treacle. It can be withdrawn from the crucible by pouring, by ladling, or by gathering. Gathering consists in thrusting the heated end of a hollow iron rod, measuring from 5 to 6 feet, into the molten mass, and turning it so as to collect a coil of the semi-liquid material. It requires some skill and practice to collect the exact weight of glass required to reproduce a given pattern, especially as a mistake in this, as in all processes of glass manufacture, is irrevocable. The molten glass, as it comes from the crucible, may be considered to be physically porous, as heat produces mutual repulsion between the molecules of a body. These physical pores have to be closed by a very gradual process of cooling, for if the process be hurried, the outer crust will be solidified, whilst the interior remains in a porous condition. So-called toughened glass has failed, because however hard the surface may

* The blocks used to illustrate this paper have been kindly lent by Messrs. Spon and Co.

be rendered by the violent contraction caused by sudden cooling, the interior remains porous, and the unnatural tension excited between the interior

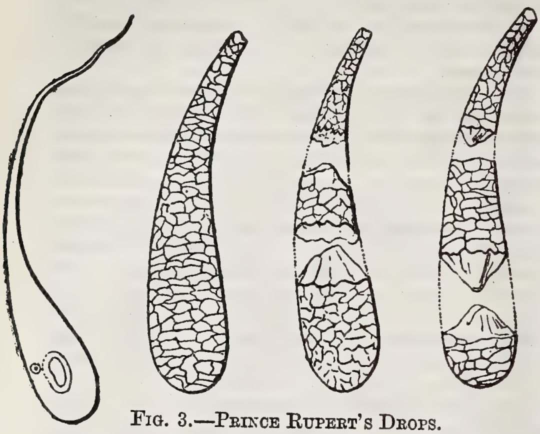

Fig. 3.—Prince Rupert's Drops.

and the surface generally ends in the destruction of both. Gradual cooling, or "annealing," is practically effected by placing the glass-ware immediately after manipulation upon movable trays, and slowly removing them in a continuous train from a constant source of heat, or by placing the ware in a heated oven or kiln, and allowing the source of heat to die out.

The effects produced respectively by the refraction, transmission, or reflection of light by glass may, in many cases, be utilised for decorative purposes. If a beam of light be transmitted through a glass prism or lustre, a more or less extended spectrum is formed in proportion to the density of the glass. If white light be transmitted through glass containing the oxide of uranium in solution, rays otherwise unseen become brilliantly conspicuous. If certain metallic oxides be introduced into a crucible, together with the mixture for transparent glass, and be dissolved throughout the mass, the resultant glass acquires the power of sifting the incident rays, and of transmitting effects of colour, according to the nature or quantity of the oxide introduced. Different permanent transmitted colours are obtained (1) by the oxides of different metals, (2) by the different oxides of the same metal, (3) by different quantities of the same oxide, or by different thicknesses of the resultant glass. The characteristic colours of the oxides of gold, silver, copper, manganese, iron, and cobalt are, respectively, pink, yellow, peacock-blue, violet, dull green, and purple-blue. Copper and iron possess two oxides each, namely, a peroxide containing a large proportion of oxygen, and a sub-oxide containing a smaller proportion. The peroxide of copper gives a blue or green colour, and the sub-oxide a ruby red. The peroxide of iron gives a yellow, and the sub-oxide a dull green. Certain oxides are valuable for their power of respectively increasing or diminishing the oxidation of other oxides. Thus, to obtain an iron yellow, which is the characteristic colour of the peroxide of iron, it is necessary to add to the mixture oxide of manganese, which, at a high temperature, parts with its oxygen and its colouring power simultaneously. The oxygen thus set free goes to the assistance of the peroxide of iron, which has a tendency to part with its oxygen, and to produce a green colour. The sub-oxide of copper has a great tendency to rob oxygen from any convenient source, and to produce a blue or green, instead of a red; it is therefore necessary, when a red is wanted, to mix with it some substance which absorbs oxygen with greater avidity. The oxide used for this purpose is the sub-oxide of tin. It often happens that in preparing the pink from the oxide of gold and red from the oxide of copper, the reductive action is carried too far, and instead of having the oxide in solution, the metal is found suspended in the glass in a state of extremely fine division. The glass in this condition reflects a red colour, but transmits an opalescent blue. If the particles of the metal be sufficiently large to reflect the characteristic colour of the actual metal, the well-known effect of avanturine is obtained. The different colours produced by the same oxide are best observed in the case of copper and cobalt. A small quantity of the per-oxide of copper gives a blue, and a larger quantity a green. In the same way a strong dose of the oxide of cobalt gives a red, a smaller dose a violet, and a comparatively minute quantity the characteristic blue, or a thick layer of cobalt glass transmits red rays, a thinner layer, violet rays, and a still thinner one, blue rays. Opacity may be produced by devitrification, by the semi-fusion of pulverised white or coloured glasses, and by the addition to transparent glass of some infusible material. Devitrification has never been pressed into practical use; the semi-fusion of pulverised glass places at the decorator's disposal a material of great strength, possessing a granular and irregular surface, together with the power of developing almost every tint of colour in an absolutely permanent condition. The process is also valuable to the manufacturer, as supplying a means of utilising waste. Opaque black glass or black enamel is formed by the addition to transparent glass of an excess of an infusible or partially fusible black oxide, as, for instance, that of iridium, of cobalt, of manganese, or of iron. White and coloured enamels owe their opacity to the oxide of arsenic, the oxide of tin, the phosphate of calcium, or to cryolite, a compound of sodium, aluminium, and fluorine, and their colours to different metallic oxides. It is cryolite which gives the opacity to the well-known hot pressed porcelain, good specimens of which have been kindly lent by Mr. J. G. Sowerby, of Gateshead-on-Tyne.

II.—Manipulation.

The molten glass gathered on the end of the hollow blowing iron may be placed in a mould, and by the pressure of a workman's breath on its inner surface, may be forced to adapt both its internal and its external surface to the form and surface of its environment. By this means the glass may not only receive the actual form of the interior of the mould, but may also be imprinted by any depressed or raised ornament, wrought on its inner surface. If instead of being expanded by the workman's breath, it be forced to adapt itself to the mould by the descent of a plunger, it will assume on its outer surface the internal form of the mould, together with any decoration which may be

wrought upon it, and on its internal surface the form and surface of the plunger.

The molten glass may also be fashioned by the breath and the simple tools of the glass-blower. The arms of the chair in which the workman sits, and the hollow and solid rods by which he holds and rotates the glass with his left hand, constitute the entire mechanism of his lathe. His principal tools are what may be called the sugar-tong spring tool, the shears, the battledore or flattening tool, together with a variety of simple clips, measure sticks, and calipers. However simple the tools may be, the variety of form which a blown bulb may be forced to assume is inexhaustible. The molten glass, when gathered from the crucible, is too fluid for immediate manipulation, and requires to be partly solidified by rolling on a polished iron slab, or by insertion in moistened wooden cup-shaped moulds, from which the glass may assume a rough outline of its ultimate form. The first process in every case is blowing through the hollow gathering iron until the mass of glass be expanded into a bulb. If the iron he held vertically, with the bulb downwards, the bulb is elongated by gravitation, and expanded at the same time; if the bulb be raised and blowing be continued, it increases in circumference only. The bulb may also be elongated by gravitation alone, assisted by a swinging motion. Whilst the bulb is being shaped with the spring tool, it must be kept in constant rotation by rolling the rod, to which it is attached upon the arms of the chair, as otherwise it would collapse. If the end of the bulb, remote from the blowing iron, be opened, and the bulb be rapidly rotated and heated simultaneously, it will suddenly fly open by centrifugal force into a flattened disc. If the disc be re-heated, and the iron held perpendicularly with the disc downwards, the disc will gradually crumple and collapse. The heat required to renew the plasticity of glass essential to manipulation is obtained by inserting the bulb or vessel into the mouth of a heated crucible, or into a furnace adapted to the purpose. If to the end of a solid mass or hollow bulb of glass a second working rod be attached by a seal of glass, and the workman recedes whilst retaining the blowing iron, and an assistant recedes carrying the second rod, the bulb or mass which unites them may be indefinitely extended. If a connection be formed between a source of molten glass, and the circumference of a heated wheel, and the wheel be caused to revolve with speed, a thread is coiled upon the wheel in an extreme state of tenuity. This thread may be spun into a decorative fabric.

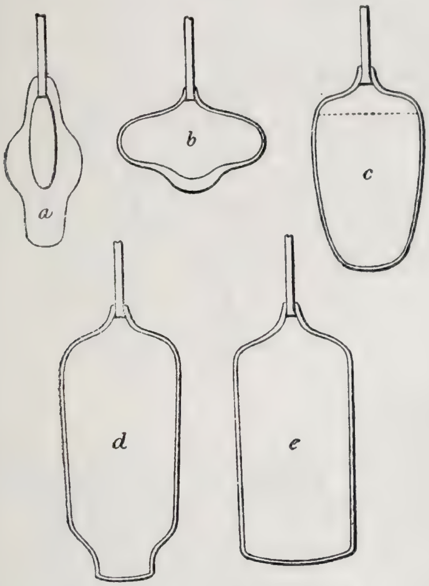

FIG. 4.—SHEET GLASS.

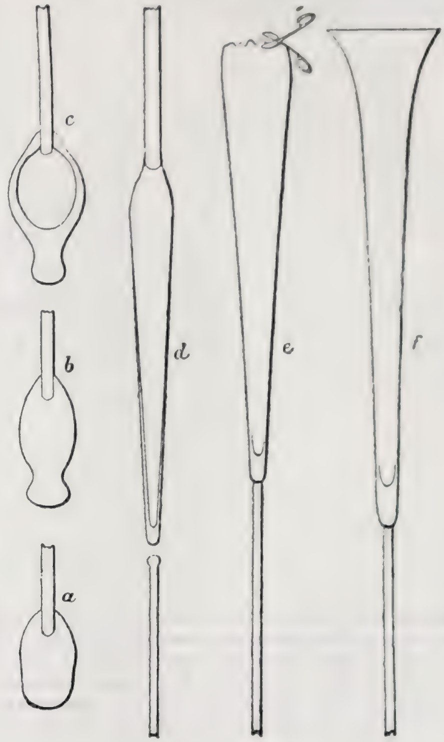

FIG. 5.—LONG VASE.

III.—TREATMENT OF SURFACE IN ORDER TO SUPPLEMENT EFFECT DUE TO NATURE OR FORM.

Decorative surface obtained by blowing into moulds.

Venetian sheet glass.
Ribbed and diamond moulded table glass.

Decorative applications to surface by heat.

1. Coloured and metallic gems, seals, and frills.
2. Etchings in gold leaf.
3. Sections of variegated cane.
4. Threading, imitation leaves and feathers, and various forms of threading.
5. Reticulated enamel ornament, with bubbles.
6. Metallic, coloured, and scale decoration.
7. Frosted glass.
8. Iridescence.

Decorative applications without heat.

1. Iridescence by corrosion and decay.
2. Cutting.
3. Engraving.
4. Sand blast process.
5. Acid.
6. Carving. Specimens lent by Mr. Thomas Webb, of Stourbridge Glass Works, Stourbridge. The origination of the process is due to Mr. Northwood.
7. Enamel painting and gilding, fixed by heat.
8. Mosaic transparent glass.
9. Mosaic opaque glass.
10. Stencilled opaque glass.

Such are a few of the processes now employed in the manufacture of glass for decorative purposes. Additional and improved processes will constantly be introduced as long as the demand for decorative glass continues. The style of the products of our flint glass manufactories has so completely changed in the course of a few years, that it is difficult to foresee upon what lines the manufacture of the future is likely to run. The change is clearly indicated by the fact that whereas flint glass was almost entirely sold by weight, sale by weight is at the present time an exception. This change indicates a loss of a staple product, namely, the heavy ware of medium or common quality. The majority of this ware is now produced on the Continent; the remainder has been retained in England by the perfection of the material of pressed glass, and of the mechanism by which it is produced. Pressing glass is a manufacture by itself, and the loss remains to the workmen and manufacturers of flint glass. Decorative glass has taken the place of that which has been lost, but it is doubtful how long it will be possible to produce it with profit, considering the increase of foreign competition. English flint glass manufactories are now mainly turning out the best quality of table glass and decorative glass, and their chief profit depends upon the invention of a succession of novelties. The only safeguard of these two branches of manufacture is to adopt an English style and an English standard. The style should be determined by consideration of the utility of the vessels produced, and of the nature of the material. It is, for instance, undesirable to expend prolonged labour upon the decoration of glass which is essentially fragile. The forms and decoration of the wares produced must be elegant and simple, and every care must be taken to develop the effects due to the natural properties of the material. The standard must be the highest possible, and no vessel should be allowed to leave the sorter's hands which is not perfect both in material and workmanship.

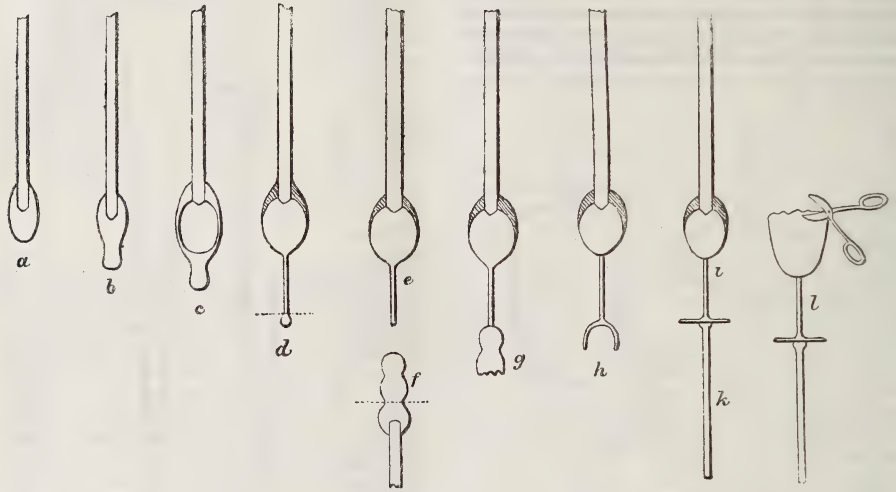

FIG. 6.—WINE-GLASS.

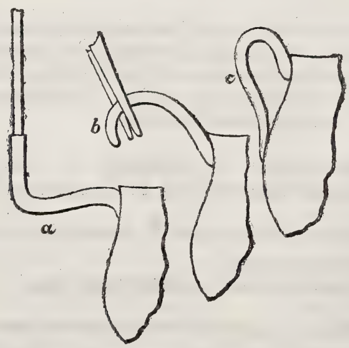

FIG. 7.—APPLICATION OF HANDLES, SCROLLS, &c.

Effectual assistance in the competitive struggle may be derived from the adoption of improved methods of working and the application of improved knowledge and of greater economy throughout all the processes of manufacture. Above all, it will be advantageous if workmen and manufacturers can discover that their true interest is identical. The Flint Glass Makers' Society makes, and has made, mistakes; but these mistakes form no valid reason for antagonism, and to the society are due the increased sobriety, intelligence, and productive capacity of the workmen.

DISCUSSION.

The Chairman, in inviting discussion, said he hoped Mr. Webb would give some further information on this important subject.

Mr. Webb said he should have been happy to say something, but really there was nothing to add to the very full information which Mr. Powell had given.

Mr. Clements said he was not practically acquainted with the manufacture of glass, but had done a little at it as an amateur, and had often witnessed the marvellous skill with which the glass-cutter could tell whether the facets of a piece of glass were of uniform size without measurement. Some time ago he endeavoured to get up an amateur society in the City, one of the objects of which was to practice glass-blowing, metal and wood turning, &c., but, unfortunately, the scheme fell through. With regard to the colours which had been mentioned. When different oxides were treated by various re-agents in a test-tube, the different colours would be seen, produced by the rays of light passing through the substance. It was well known that colour was caused by certain rays of light being absorbed, and others being allowed to pass, or being reflected. If all the rays were reflected or transmitted, the colour was white; if they were all absorbed, it was black; but if some only were absorbed, the remainder would cause the colour. He understood that foreign competition was very severe in the glass trade, but that was the case with many other trades as well. The sand-blast was shown in operation at the Loan Exhibition at South Kensington some years ago.

The Chairman said that as there seemed to be no one inclined to discuss the subject, he must conclude the proceedings by proposing a vote of thanks to the reader of the paper. He must say he was not surprised that there was no discussion, for really the paper was so full of matter, that they had as yet been hardly able to sort it in their minds. There was, as Mr. Powell had told him before coming in the room, enough matter in the paper for three lectures. As far as he was concerned, one very clear idea brought home to his mind was, that at all events, we had here a manufacture with which, up to the present time, machinery had little to do. When he saw the rough tools with which the beautiful articles were made, he thought that even Mr. Ruskin might find some pleasure in contemplating the glass manufacture. There did not seem to be any portion of the subject in which machinery had intervened, except in that one process of the sand-blast; and it was certainly some satisfaction to see that there was still one branch left in which real handicraft skill had to do the largest portion of the work; and they could all reciprocate the wish which the reader of the paper had expressed, that they should have an English style, and that this industry, which was of enormous importance, should prosper in this country. They must all agree with him that one of the best chances of its succeeding, would be for the workmen and manufacturers to come to the conclusion, and to act upon the conclusion, that their interests were identical. He did not know that there was anything so likely to conduce to that end, as when a large employer of labour spoke as Mr. Powell had spoken, of the society which came particularly within his purview, the Flint Glass Makers' Society, and when they found that the manufacturer was not treating the trade society as an opponent, but gave it full credit for all the good which it could and did do. He was sure they owed a hearty vote of thanks to Mr. Powell, for the admirable paper he had read.

The vote of thanks was passed unanimously, and the proceedings terminated.

MISCELLANEOUS.

TECHNICAL COLLEGE.

The first stone of the City and Guilds of London Technical College, Finsbury, a building adjoining the Cowper-street Schools, was laid on Tuesday, 10th inst., by H.R.H. Prince Leopold. The classes of young men, previously held in the schools, were attended in 1880 by 422 students, and related chiefly to applied physics and chemistry. The new college will be a plain building in classical style. It will contain 32 rooms, comprising a large laboratory, two lecture theatres, class rooms fitted with appliances for teaching various branches of physics, chemistry, and mechanics, rooms for drawing, professors' rooms, workshops, an engine room, and clerks' offices. The cost of the building and fittings is estimated at £20,000 or £25,000. The funds have been provided by the City companies and the City of London, and are administered by the City and Guilds of London Institute for the Advancement of Technical Education.

The Lord Chancellor (Lord Selborne), on behalf of the Council of the City and Guilds of London Institute, welcomed his Royal Highness, and said that the institute now conducted local examinations in subjects of 32 industries, and in 85 different places. The number of candidates at the examinations three years ago was 202, last year it was 316, and this year there were 2,401 entries. Through the liberal co-operation of the Royal Commissioners of the Exhibition of 1851, a valuable site of ground at South Kensington had been given, or let at a nominal rent, to the Institute, for the purpose of erecting upon it a central institution, and sufficient funds were already provided to make it certain that it would soon be established. The object of that central institution was to give the highest kinds of instruction necessary to qualify persons to become teachers of the industrial arts and their principles all over the country. The Finsbury College was not to interfere with the necessary training of the factory and the workshop, but it was meant to give artisans that knowledge which would enable them to receive their training in the most intelligent manner. The institution had received from 28 firms connected with the business of cabinet-making and furnishing an application that their trades might be admitted to the benefits of the institution, and it was intended that they should be admitted. The institution held an intermediate place between the central institution at South Kensington and the upper schools, whether technical or middle-class schools, from which the pupils would originally come, and at the Finsbury College they would receive a sound foundation of knowledge for the practice of their different arts and trades.

Prince Leopold having guided the stone into its proper position, said, my Lord Mayor, my Lords, Ladies, and Gentlemen,—I have now had the pleasure of laying the foundation stone of the first technical college ever erected in London. The report presented by the Council of the City and Guilds of London Institute for the Advancement of Technical Education will inform those interested in this most important undertaking of the magnitude of the work, and of the energy and perseverance with which it has hitherto been pursued under somewhat adverse circumstances. The object which the institution has proposed to itself is a truly national and patriotic one. It has proclaimed its determination to enter into a generous rivalry with other countries in those branches of trade and commerce in which one must needs confess that our native industries have, of late years, not taken the position which we, as Englishmen, would wish them to occupy. The old apprenticeship system, whatever its merits may be, and whatever good work it may have

done in the past, is not equal to the exigencies of the present age, and we are beginning to realise that a thorough and liberal system of technical education must be placed within reach of the British artisan, in order to enable him to hold his own against foreign competition; and when this is done, I believe, as I have said on a former occasion, that we need not fear any rivalry in the world.

Mr. F. J. Bramwell, F.R.S., as Chairman of the Executive Committee of the Institute, proposed a vote of thanks to his Royal Highness, which was seconded by **Mr. Mundella, M.P.**, and carried unanimously.

DOMESTIC SANITATION.

At a meeting of the Ladies' Sanitary Association, held in the Rooms of the Society of Arts on Tuesday, 10th inst., H.R.H. the Princess Christian presented the prizes and certificates adjudged by Dr. B. W. Rtchardson, F.R.S., to successful candidates in the examinations on the subject of his lectures on Domestic Sanitation.

Dr. Richardson said—The presence of the Princess Christian to distribute the prizes connected with the lately delivered course of lectures to the Ladies' Sanitary Association, makes me recall an incident which, though it occurred long ago, is in some way connected with the present. In the year 1855, when sanitary science was not so popular as it is now, when, in fact, it was an ignored if not a tabooed subject, a young and enthusiastic sanitarian ventured to initiate and edit a new journal called the *Journal of Public Health*. He took great pains to get the best contributors he could, and to make the work as attractive as possible, and spent some time in inventing a motto for the title page. Many of these efforts were successful, and his motto, "*National health is national wealth*" has passed into a proverb. But in other respects his work was a failure; it got no circulation. In despair he was about to give up sanitary labours altogether, when one evening he received a short note from his good friend Sir James Clarke. Sir James in effect wrote, "I send you a hasty line to tell you something that will do you good. I had a conversation today with Prince Albert. The Prince has seen your journal, and is pleased with the tone of it. He considers your article on the sanitary condition of the army very useful, and likes your motto, 'National Health,' &c., extremely. He has directed two copies of the journal to be sent regularly to the Royal Library, and wishes you all success in your work." I can assure you, ladies and gentlemen, that no poor traveller on sandy desert ever drank from spring of fresh water more cheerfully than this sanitarian did from that intelligence, for it came to him, not only as an encouragement from the Prince Consort, but as from a pioneer in sanitary progress, who was one of the first to recognise that a truly healthy nation must be a happy, a contented, and a prosperous nation, and who had practically striven to set the foundations of that health, happiness, content, and prosperity, by showing how to lay them in good and wholesome and beautiful homes for the people. From the time he received the note of Sir James Clarke, this sanitarian never again hesitated. By lectures, by statistics, by argument, and, when the occasion offered for addressing great numbers, by allegory, he tried to teach still that "national health is national wealth." And now he has this new recognition, which will always be remembered, that after a quarter of a century, a Royal lady, who is amongst the nearest to the good and illustrious Prince, comes forward to give away the prizes, which completes his latest and, in some degree, most successful effort as a sanitary reformer. The course of lectures which has just closed is one of several courses that have been delivered before the Ladies' Sanitary Association. It was suggested to the Association by the address I had the honour to speak before the last Congress of the Sanitary Institute, so ably presided over at Exeter by Lord Fortescue, and owing to the zeal and energy by which the movement has been promoted by the committee, and the unceasing activity of the secretary, Miss Rose Adams, it has been singularly fortunate. Nearly three hundred pupils have been in regular attendance, and have formed a class it has been, indeed, a real pleasure to instruct. The subjects of food and digestion, of the circulation of the blood, of nutrition, of vital warmth, of breathing, and of ventilation, in their various adaptations to domestic sanitation, have been most carefully discussed and illustrated, while the handsome prizes offered by the distinguished veteran in the sanitary cause, Mr. Edwin Chadwick, have made the work go forward with such enthusiasm, that no fewer than seventy-five competitors (ladies and gentlemen), with a grand total of over fifteen hundred closely-written competitive pages, have entered the field in friendly contest. Three sets of papers have thus been composed on seventeen questions submitted for answer, and so excellent are the majority of the papers, so clear, so methodical, so correct, that adjudication has almost been a penalty. The papers have all come to me anonymously, marked simply by a number, so that I am ignorant at this moment to whom the honours are awarded. I wish I could have awarded to everyone, for none are actually unworthy of recognition, while to those who are the recipients, the merit is indeed of signal character. There are two "Chadwick" Prizes, a first of ten, a second of five guineas; a third prize of two guineas, by Lady Mount-Temple; a fourth prize of one guinea, by Miss Marshall; a fifth of one guinea, by myself; five special first-class certificates of merit, sixteen first-class certificates of merit, and nineteen second-class certificates of merit. In commenting, in the briefest manner, on the results of this trial of skill, I will allude mainly to one or two of the most practical. In some of the essays, certain candidates have evinced more knowledge and skill than the rest, but all have shown that they have a sound knowledge of four subjects, viz., the relative values of the substances used as foods; the circulation of the blood; the process of breathing, with the conditions which produce a pure and healthy dwelling; and the management of a sick room. On the last topic, such thoughtful care has been bestowed that, if I were a sick man, I do not know where I could look for intellectual and skilful nursing, with so much hope of advantage, as amongst the seventy-five essayists who have answered the questions on this all-important domestic accomplishment. And now, my Lord Aberdare, the time has come when those who give, those who receive, and those who look on will experience equal delight. Her Royal Highness will distribute to the successful candidates their well-earned rewards.

Mr. Chadwick, in moving a vote of thanks to Her Royal Highness, said—It is permitted me to move a vote of thanks to her Royal Highness for the honour of her attendance here to-day, and the high sanction she has conferred on our proceedings. In doing so, I venture to express the gratification which I feel will be felt by all, as I may presume to take it as a manifestation of the continued interest bestowed by our Royal family on sanitary science—the improvement of the health of the people. In reference to it, I had grounds for the statement that, if all the owners of cottages in the Empire exercised the same sanitary care that has been exercised on the cottages on her Majesty's private estates, the general sickness and death-rates would be reduced one-third; that is to say, it would be as if on every third year there were a jubilee, and no sickness and no deaths. At the first International Exhibition, when Royal Princes exhibited chiefly decorative objects of art, the one object which her Royal father gave as his sole personal contribution to the International Ex-

hibition was a model cottage—a model of the available sanitary principles of construction. Where that model has been followed with the sanitary principles embodied, as they have been very extensively, the death-rates have been reduced by more than one-third, as compared with the rates specially prevalent amongst the common dwellings of the same classes of the people. Now the principles propounded in the able sanitary lectures which Dr. Richardson has given, and for the proofs of attention to which the prizes have been awarded, relate mainly to principles of sanitation, food, clothing, and to the use of the house, those accessories would add largely to the gains from the improved construction of the model cottage of her Royal father, and would, I expect, bring up the total gains from its use to one half or more. I, therefore, move that our cordial thanks be given to her Royal Highness for the sanction she has given to our objects by the honour of her attendance, and the assurance it implies of the continued support of herself, as a member of her illustrious house, to labours, such as those of the Ladies' Sanitary Association, for the prevention of suffering, and for improving the health of the people.

The motion was seconded by **Lord Alfred S Churchill**, and **Lord Aberdare** (the Chairman) responded on behalf of the Princess.

BREAD REFORM LEAGUE.

Miss M. Yates, the Hon. Sec. of the Bread Reform League, has written a letter to the *Miller*, in answer to the remarks of Dr. Graham, noticed in this *Journal* (April 8, p. 448), and the following extracts are here given at her request. In a previous letter she points out that although it is said that whole-meal has only 49·7 per cent. of phosphoric acid, and only 3·4 per cent. of lime, whilst white flour has 43 7 per cent of phosphoric acid, and 6·0 per cent. of lime, as Professor Church states "That 1 lb. of whole-meal contains 119 grains of mineral matter, whilst 1 lb. of fine white flour only contains 49 grains. These per-centages show that in a pound of whole-meal there would be 59 1 grains of phosphoric acid, whilst in fine white flour there would only be 21 3. The same figures show that 1 lb. of whole-meal instead of containing less lime has 4·0 grains of lime, whilst a pound of fine white flour has only 2·1 grains of lime." As Dr. Edward Smith states "That a man requires daily from 32 to 79 grains of phosphoric acid, it is at once evident what an advantage whole-meal has over fine white flour, and how essential it is that people who cannot afford a plentiful supply of meat, milk, or eggs, should be able to obtain bread which contains this phosphoric acid, for it is a component part of the blood, brain, and nerves."

"But, as I have before stated, we are not relying upon mere chemical analysis to prove the superior advantages of wheat-meal bread, but upon practical experience of its benefits. Men who can easily carry on their backs from four to five hundred pounds weight can scarcely be considered 'poor representatives of physical force.' I myself have often seen this done by men whose principal food was wheat-meal bread, and who scarcely ever touched meat, but who said they could not work well on white bread alone, as they felt hungry again soon after eating it."

In the second letter, Miss Yates quotes from Drs. Edward Smith, Lankester, Pavy, and Parkes, to prove that albumen is as essential as fibrine, and cannot, therefore, be any disadvantage in a bread, and that the cerealine "is, from a dietetic point of view, most valuable, for, as Dr. Pavy observes, 'the power of digesting starch is not by any means such as to secure the digestion of all that enters the alimentary canal,' it is reasonable to suppose that the cerealine (which resembles the extract of malt, which is now being so extensively prescribed) will assist the digestion of the bread. The benefit derived from food depends, not on the amount eaten, but on what is assimilated." Miss Yates concludes her reply as follows:—

"Experience shows that those nations who do not eat meat, or with whom meat is only an occasional luxury, almost invariably adopt brown bread. There are numerous examples of people being healthy and vigorous without ever touching meat, when their principal food is brown bread. I have already mentioned the Arab fellaheen, Turkish Hamals, and Sicilian peasants. That I have seen myself personally. From friends I hear that the Hindoos of the North-Western Provinces can walk fifty or sixty miles a day with no other food than 'chapatties' made of whole-meal with a little 'ghee' or Galam butter. The Swedish, Norwegian, and Russian peasants live principally on brown bread. The French peasantry, at the beginning of the present century, lived on brown bread, and the working classes of England have only generally adopted white bread during the last hundred years. Innumerable examples will prove that the majority of the human race have used brown bread, and considered white bread a luxury. However much chemists may now differ, science must eventually corroborate this practical experience. Now that wheat-meal bread can be obtained in such a palatable and digestible form, we are certain that its general adoption would be a great benefit to both rich and poor, for they will find by experience that it sustains and nourishes them better than white bread does, and that a much larger amount of work can be done on it alone than on white bread alone.'

NOTES ON AMERICAN SCIENCE AND MECHANISM.

THE PHOTOPHONE.

At the meeting of the National Academy of Sciences, in Washington, U.S.A., on the 21st April, Professor Graham Bell made a communication of his most recent researches on the principles of the photophone. On his return from Europe a discovery that had been made relative to the marked results obtained when lamp-black formed an ingredient in diaphragms composed of silks and worsteds, led to this pigment being tried alone, with the result that when a teaspoonful of lamp-black was placed in a test tube and exposed to an intermittent beam of sunlight, the sound produced was the loudest that has yet been obtained. When a smoked piece of glass was held in the intermittent beam, the sound was loud enough to be heard in any part of the room. When the beam was thrown into a resonator, the interior of which had been smoked over a lamp, curious alternations of sound and silence were observed. The interrupting disc was set rotating at a high rate of speed, and allowed to come gradually to rest. An extremely feeble musical tone, at first heard gradually, fell in pitch as the rate of interruption grew less. When the frequency of the interruption corresponded to that of the fundamental of the resonator, the sound was so loud that it could easily be heard by hundreds of people.

There seems reason to think that a practical result of the discovery here described will be the use of lamp-black in an articulating photophone, in place of the electrical receiver hitherto employed. It is now definitely established that the colour and the physical condition of the solids operated on determine the intensity of the sonorous effects. The explanation given by Professor Bell is to the following effect:—Lamp-black is a substance which becomes heated by exposure to rays of all refrangibility, and a mass of this substance may be looked upon as a sponge, with its pores filled with air instead of water. When a beam of sunlight falls upon this mass, the particles of lamp-black are heated, and, consequently, expand, causing a contraction of the air spaces or pores among them. Under these circumstances a pulse of air should be expelled, just as water would be squeezed out from a sponge.

The force with which the air is expelled must be greatly increased by the expansion of the air itself, due to contact with the heated particles of lamp-black. The converse process takes place when the light is cut off, the particles become cool and contracted, the air space is enlarged, and, in consequence, a partial vacuum is formed, into which there is a rush of air from the outside. Owing to the great molecular disturbance that takes place in lamp-black, it is imagined that this substance will entirely supersede the costly selenium electric receiver.

Very curious results were obtained in course of experiments with the solar spectrum. Different substances—solids, liquids, and gases—were used as receivers, disclosing the fact that the maximum of sound produced with them varied in point of position on the spectrum in a remarkable manner. With the lamp-black receiver a continuous increase in the loudness of the sound was observed upon moving the receiver gradually from the violet into the ultra red, far out into which the point of maximum sound lay. Beyond this point a slight motion of the receiver caused complete silence, so abrupt was the passage from the maximum sound into its absence. These experiments have led to the construction of a new instrument for use in spectrum analysis. The eye-piece of a spectroscope is removed, and sensitive substances are placed in the focal point of the instrument, behind an opaque diaphragm containing a slit. Those substances are put in communication with the ear by means of a hearing tube, and thus the instrument is converted into a "spectrophone." While it is not claimed that the ear can, for a moment, compete with the eye in the examination of the visible part of the spectrum, in the invisible part beyond the red, where the eye is useless, the ear will be invaluable; and for this reason the "spectrophone" must ever remain an adjunct to the spectroscope, in addition to its having a wide and independent field of usefulness in the investigation of absorption spectra in the ultra red.

The Keeley Motor.

There are few at the present time acquainted with the higher walks of mechanism who have not heard of the "Keeley Motor." Now, what this "motor" is, no person seems to know; what it proposes to do after it has once been brought to a state of completion is really invaluable, *inter alia*, from the charming simplicity with which its claims are put forth, viz., to get an enormous amount of mechanical power from nothing, or at any rate from nothing at all worth speaking of; for instance, a glassful of water to drive a railway train for over a hundred miles. Keeley was confident of his being able to solve the problem, and the stock-holders and stock-dealers equally confident that there was something in it. It is true that it has long been the standing ridicule of mechanics of the every-day school, and for several years reputable journals such as the *Scientific American* have always linked the word "deception" to the usual title of the inchoate power; but what more easy than to persuade moneyed speculators that all great and new discoveries are subject to detraction? Accordingly money has flowed in plentifully, until recently when stock holders began to demand that they must see something, plenty of time having surely elapsed since first the stock was thrown into the market. But as Mr. Keeley retained the "secret" in his own hands, he was master of the situation, and if they would not advance more money it would be their own loss, as his invention was now almost perfected. A "first public exhibition" of the Keeley engine was, however, determined upon, and was given in Philadelphia on the evening of the 22nd April, in presence of a large body of New York men, among whom are some of fairly high social and political standing, but none whose names are recognised as belonging to the world of practical machines. When the visitors were seated, they saw before them a well-polished steel machine composed of tubes and globes. Like a scene connected with conjuring apparatus, the first act consisted in removing every cock and tube, ostensibly to show that the apparatus was empty. Lights were placed underneath, and the visitors were invited to look into and through the various chambers. The performance then commenced by one of the company pouring a glass of water into half-a-dozen funnel-topped tubes, and in exactly twenty-nine seconds after the last drop went in a pressure was generated sufficient to raise a six-foot lever (one inch fulcrum), upon which were hung 700 pounds weight. The pressure was asserted to be 15,000 pounds to the square inch. Pausing for a moment, I may remark that innumerable Englishmen, and also numerous Americans, are aware that a "Geyser" apparatus is, and has for years, been in London an article of commerce, by means of which cold water poured into a reservoir at the top emerges, after a few seconds, from a faucet at the bottom, heated to the boiling point. But perhaps Mr. Keeley's visitors on the occasion referred to were not quite aware of what takes place when a drop of water is allowed to come into contact with a hot metallic surface. The vapour said to create the pressure, in the experiment now being described, was then passed into a steel cylinder about 30 inches long, by 5 inches in diameter, through the centre of which was stretched an ordinary piece of piano wire, and, by means of some mysterious influence exerted by a kind of mammoth "tuning fork," was said to be "vivified" by its vibrations. This vapour was then conveyed to the engine in another room, to which all the visitors were then invited to move. Here was placed an engine, or piece of mechanism, that at present must be considered as indescribable. After the opening of some cocks, something, that was termed a "spirophone," contained in one of the cylinders, or rather drums, of the mechanism began to roar, and a shaft connected with it began to revolve rapidly. The rapidity of the revolutions of the engine were controlled by Mr. Keeley striking an iron disc or drawing a bow over a tightly stretched steel wire. Now, what does all this pretty piece of mechanical legerdemain amount to? will be the inquiry of the sober, common-sense mechanic. The writer has sought to obtain at head-quarters in New York some reliable information concerning this alleged "new power," which he could place before the readers of the *Journal of the Society of Arts*, but has quite failed up to the present time in being able to accord it a position of reliability or genuineness, notwithstanding that Commander Gorringe and others speak of what they saw as perfectly wonderful.

New Ammonia Engine.

Different altogether from the "motor" just spoken of is a "low temperature motor," into which a somewhat searching examination has just been made by the chief engineer of the Navy Department of the United States of America. This differs *ab initio* from the "Keeley Motor," in that there is no alleged mystery, everything being explainable on scientific principles. Originating in a machine in which ammonia was used as a means of producing ice, experiments have led to the discovery of a motor which, when completed, will, it is stated, prove of inestimable value. Ammonia being converted into gas under high pressure at ordinary temperature has about three times the expansive force of steam. While water requires to be subjected to a high degree of heat ere its powers can be put forth, ammonia, on the contrary, puts forth its power at an ordinary temperature. The difficulty heretofore has been to get the ammoniacal gas condensed after it has operated on the end of a piston. It is now believed by Chief Engineer Isherwood, who is acting in this matter with Professor John Gamgee, that this difficulty has been overcome. In the new ammonia engine there is a high pressure boiler where the ammonia is converted into gas by the heat in water of ordinary atmospheric temperature, and a low-pressure boiler, in which

ammonia is kept at a considerably less tension than in the other, and with which the engine is operated. After doing its work, the cooled and shrunken gas and liquid are discharged by an ejector worked by the higher pressure in the high-pressure boiler. This excess of ammonia in the liquid form is pumped from the low-pressure back to the high-pressure boiler, while the excess of heat is continually being converted into the mechanical work done by the engine. The high character of the men engaged in working out this idea, and the open manner in which they state the whole principles upon which every action is based, proves to some extent a guarantee of the possibility of something valuable being eventually achieved by its agency, for, unlike the "Keeley Motor," there is in the ammonia motor no secrecy as regards either principle or mode of action.

New York, April 26th, 1881.

METEOROLOGICAL SOCIETIES.

The subject of Mr. G. J. Symons's presidential address, at the last annual general meeting of the Meteorological Society, was "The History of English Meteorological Societies—1823 to 1880." The earliest English effort at forming a meteorological society, or, at any rate, at securing observations made with comparable instruments, recorded upon a uniform system, was made in 1723 by Dr. James Jurin, who was then secretary to the Royal Society. In the "Philosophical Transactions" for that year will be found an able Latin address by Dr. Jurin, in which he anticipates nearly all the conditions which we now consider essential for comparable observations. This appeal did not lead to much being done, and 20 years later, on May 3rd, 1744, another attempt was made by Mr. Roger Pickering, F.R.S., who read before the Royal Society a paper, entitled "Scheme of a Diary of the Weather, together with Draughts and Descriptions of Machines subservient thereunto." The Royal Society did not begin their register until 1774, and then they only continued it consecutively until 1781, after which they allowed several years to elapse before they again undertook it. In 1780, the Meteorological Society of the Palatinate was formed, and in the following year they commenced their observations. The secretary of this Mannheim Society died in 1790, and from that time the society languished, and finally became extinct amidst the troubles and wars of the French Revolution. The first meeting for the formation of the Meteorological Society of London was held on October 15th, 1823, at the London Coffee-house, Ludgate-hill, Luke Howard, Thomas Forster, Dr. Clutterbuck, J. G. Tatem, &c., being among its chief supporters. The society languished soon after its foundation, but was revived in 1836, and finally died about 1843. Seven years afterwards the British Meteorological Society was founded by Dr. Lee, Admiral Smythe, and many of the supporters of the old society. In 1866, the society obtained a Royal Charter of Incorporation, and, ceasing "to be the BRITISH *Meteorological Society*, became THE Meteorological Society."

GENERAL NOTES.

Solar Engine.—The following description of a solar engine is given by Mr. G. F. Rodwell, in his report of the meeting of the French Association for the Advancement of Science, at Algiers, in *Nature*:—"In the Agricultural Exhibition one of the most interesting machines is the solar engine, the boiler of which is placed in the axis of a mirror 14 feet in diameter, and formed of three portions of hollow truncated cones, so as to get a close approximation to the parabola. When the sun shines a pressure of from three to four atmospheres is produced in the boiler, and a force of one-horse power is produced through the intervention of an ordinary steam-engine. The mirror is of silvered copper; the boiler is blackened and is surrounded by a glass cylinder, which of course permits the passage of the sun's heat through it, but obstructs its escape after absorption. The whole thing costs 4,000 francs, and it could be used in many countries for at least 200 days in the year.

Fruits from the West Indies.—The success which has attended the experimental shipments of ripe fresh fruits from Australia has set the West Indians on their mettle, and several planters have turned their attention to the cultivation of oranges, pine-apples, bananas, and other fruits, especially for shipment to Europe. America has hitherto been the chief customer of the West Indian Islands for fresh fruits, but there is no reason why England should not share in the fruit produce of her nearest tropical colonies. At the present time the trade in pine-apples is pretty well monopolised by the Bahamas, from whence we receive the cheap fruits which are displayed in a more or less damaged condition on the costermongers' barrows in the streets of London during the summer months. But if more care were taken in selecting and packing the fruit, pine-apples might be received in excellent condition from all the West Indian Islands, and not only pine-apples, but bananas and oranges. The greater expense which would be incurred by a little more care in packing the fruit, and the additional cost of freight, would be more than covered by the higher prices which would be realised for ripe oranges, for instance, which could be sold at the time when such a luscious fruit would be most highly appreciated, viz., during the summer months, and at a time when the ordinary supply of European oranges would not be in the market. One enterprising cultivator in Jamaica, who has lately taken to growing pine-apples for export, has realised as much as £80 per acre. The trade in bananas is also increasing, at least, so far as Jamaica is concerned, and last year nearly half a million bunches were exported from that island, valued at over £38,000. In the case of oranges the value exported last year from Jamaica was over £11,000.
Colonies and India.

Gum Arabic at Trieste—Mr. L. Ordega, Consul-General of France at Trieste, has furnished, under date of August 10, 1880, some statistics relating to the amount of gum arabic which arives at Trieste from Africa. The total importation and exportation during the years 1877, 1878, and 1879, was as follows:—

	Importation.	Exportation.
1877	2,695,100 kilos.	2,707,600 kilos.
1878	2,726,300 ,,	2,796,400 ,,
1879	4,638,400 ,,	3,080,900 ,,

The gums are divided into thirty-two grades, the prices of which vary from about 75 dollars for the best, to as low as 13 dollars per 100 kilos. for the commonest kinds. The available stocks during 1877 amounted to 1,700,000 kilos., but, in 1879, they exceeded 3,600,000 kilos, and even this enormous reserve was hardly sufficient to satisfy the demands from the various markets of Europe. On August 1, 1880, the stock on hand at Trieste was as follows:—

	Kilos.
Arabic	387,000
Ghizira	57,000
Sennary	1,400
Suakin	313,000
Gedda	79,000
Total	838,000

The construction of new routes has rendered the transport of the Suakin gum more easily from its place of origin to the port of debarkation. Owing to the interruption of communication caused by certain rains called "karif" in Egypt, no arrivals whatever from Suakin reached Trieste during the whole of last October.

Fruit Gardens of Bohemia.—The number of fruit trees in Bohemia of all sorts, but chiefly apples, appears, from some recently published statistics, to amount to 14,000,000. Of these, 10,000,000 are in gardens, 1,600,000 in waste lands, and about 2,000,000 on the sides of the public roads. The number of young trees annually planted is about 1,500,000. Between 6,000 and 7,000 miles of road are planted with fruit trees, mostly of the best sorts, and the revenue therefrom is very large. The fruit is largely exported to the north of Germany and Russia.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at eight o'clock:—

MAY 18.—"The Electrical Railway, and the Transmission of Power by Electricity." By ALEXANDER SIEMENS. Dr. SIEMENS, F.R.S., will preside.

FOREIGN AND COLONIAL SECTION.

Tuesday evenings, at eight o'clock:—

MAY 31.—"The Principality of Loo Choo." By Consul JOHN A. GUBBINS.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday evenings, at eight o'clock:—

MAY 26.—"Telegraphic Photography." By SHELFORD BIDWELL. Prof. W. G. ADAMS, F.R.S., will preside.

INDIAN SECTION.

Friday evenings, at eight o'clock:—

MAY 13.—"Burmah." By General Sir ARTHUR PHAYRE, G.C.M.G., K.C.S.I., C.B. Sir RUTHERFORD ALCOCK, K.C.B., will preside.

Members are requested to notice that it may be necessary to make alterations in the dates of the above papers.

CANTOR LECTURES.

Monday evenings, at eight o'clock:—

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. BRUDENELL CARTER, F.R.C.S. Three Lectures.

Syllabus of the Course.

LECTURE I.—MONDAY, MAY 16.

Introductory. Nature of colour vision generally. Solar light—its composition. The prismatic spectrum. Invisibility of certain elements of the spectrum to the colour-blind. Appearance of the combinations of the remaining elements. Varieties and definitions of the resulting colour blindness.

LECTURE II.—MONDAY, MAY 23.

Mistakes of the colour-blind in daily life. Their methods of endeavouring to counteract the consequences of their defect. Modes of testing for colour blindness. Sources of error in testing. The actual prevalence of the affection in this and other countries, and in different classes of the population.

LECTURE III.—MONDAY, MAY 30.

Industries chiefly affected by colour blindness—Engine-drivers, pilots, artists, letter-sorters, drapers, painters, &c., &c. Recent legislation affecting colour blindness in America, and urgent need for it in this country. Conclusion.

ADMISSION TO MEETINGS.

Members have the right of attending all the Society's meetings and lectures. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 16TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. R. Brudenell Carter, "Colour Blindness, and its Influence upon Various Industries." (Lecture I.)
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Resumed Discussion on Mr. J. Freeman's Paper, "Land Law Reform."
Victoria Institute, 7, Adelphi-terrace, W.C., 8 p.m. Sir Joseph Fayrer, "The Rainfall of India."
Social Science Association and Law Amendment Society, 1, Adam-street, Adelphi, W.C., 8 p.m. Lord Norton, "A Consolidation of the Acts relating to Reformatory and Industrial Schools."

TUESDAY, MAY 17TH...National Health Society (at the HOUSE OF THE SOCIETY OF ARTS), 7½ p.m. Mr. S. Stevens Hellyer, "The Science and Art of Sanitary Plumbing." (Lecture I.)
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Non-Metallic Elements." (Lecture IV.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. John I. Thornycroft's Paper, "Torpedo Boats and Light Yachts for High-Speed Steam Navigation."
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m.
Pathological, 53, Berners-street, Oxford-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.

WEDNESDAY, MAY 18TH...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. Alexander Siemens, "The Electrical Railway, and the Transmission of Power by Electricity."
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Richard H. Curtis, "Comparison of Robinson's and Osler's Anemometers, with Remarks on Anemometry in General." 2. The Hon. F. A. Rollo Russell, "Notes on Waterspouts observed at Cannes in January or February, 1872." 3. Mr. Alexander Beazeley, "Some Swedish Meteorological Observations in connection with the Return of the Seasons."
Pharmaceutical, 17, Bloomsbury-square, W.C., 11 a.m. Annual Meeting.
Archæological Association, 32, Sackville-street, W., 8 p.m. Dr. Phené, "Oak Figures Discovered in Britain, Brittany, &c."
Sanitary Institute of Great Britain, 9, Conduit-street, W., 8 p.m. Adjourned Discussion on the Address by Dr. Richardson, "Suggestions for the Management of Cases of Small-pox and of other Infectious Diseases in the Metropolis and Large Towns."

THURSDAY, MAY 19TH...Bankers' Institute (in the Theatre of the London Institution, Finsbury-circus, E.C.), 6 p.m. 1. Sir Richard Temple, "The General Monetary Practice amongst the Natives of India, with some estimate of the use and probable future absorption of Silver as Coin; and an account of such practices amongst the Natives as have a Banking character, and lead up to the larger Banking operations of the Country." 2. Annual General Meeting.
Royal, Burlington-house, W., 4½ p.m.
Antiquaries, Burlington-house, W., 8½ p.m
Chemical, Burlington-house, W., 8 p.m. 1. Mr. Lewis T. Wright, "The Re-action between Hydrogen and Nitric Oxide in the presence of Spongy Platinum." 2. Mr. O. V. Pisani, "A Method for the Ready Estimation of a Soluble Sulphide and Free Sulphurous, or Free Sulphuric Acid, even in the Presence of Sulphates."
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Frank Roland, "The Art Decoration of Auditoria."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Paramagnetism and Diamagnetism." (Lecture IV.)
Royal Historical, 22, Albemarle-street, W., 8 p.m.
Numismatic, 4, St. Martin's-place, W., 7 p.m.
Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

FRIDAY, MAY 20TH....Royal United Service Institute, Whitehall-yard, 3 p.m. Vice-Admiral G. G. Randolph, "The Relative Values of the Group of Three and Two as the Unit for Naval Tactics."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Mr. W. H. Pollock, "Shakspeare's Criticism."
Philological, University College, W.C., 8 p.m. Anniversary. Annual Address by the President.
National Health Society, 23, Hertford-street, W., 4 p.m. (Drawing-room Lectures.) Dr. Siemens, "Stoves and Grates."

SATURDAY, MAY 21ST....Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. E. Turner, "Russian Literature." (Lecture I.) Pouschkin.

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FRIDAY, MAY 20, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Thursday, June 2nd. The cards of invitation are now in course of issue.

CANTOR LECTURES.

The first lecture of the fifth Course, on "Colour Blindness and its Influence upon Various industries," was delivered by R. BRUDENELL CARTER, F.R.C.S., on Monday, 16th inst.

The lectures will be printed in the *Journal* during the autumn recess.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, will be opened to-morrow (Saturday). The following are the exhibitors:—J. G. Crace and Son; Morant, Boyd and Blandford; Jackson and Graham; Gillow and Co.; Holland and Sons; Howard and Sons; Wright and Mansfield; Collinson and Lock; Gregory and Co.; Shoolbred and Co.; Johnstone, Jeans and Co.; Sidney Phelps; Edward Sears; and the National School of Wood Carving. A non-transferable season ticket for the Exhibition will be sent to any Member of the Society who may apply for one to the Secretary.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Dr. Hullah, the Society's Examiner, at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 4th July, 1881.

Full particulars can be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

APPLIED CHEMISTRY AND PHYSICS SECTION.

Thursday, May 12, 1881; Professor F. A. ABEL, F.R.S., Vice-President of the Society, in the chair.

The paper read was on—

RECENT PROGRESS IN THE MANUFACTURE AND APPLICATIONS OF STEEL.

By Professor A. K. Huntington,
King's College, London.

At first sight, the title which I have given the paper I am about to bring before you this evening, might lead some to suppose that it was intended to deal with very recent events, such as might have occurred within the last few months, or say a year. Such anticipations would be fully justified were I to address you on recent progress in the applications of electricity, for this offspring of intellects of our own era makes marvellous progress from day to day, until one feels tempted to concede to it a position in the universe similar to that occupied in the human body by nerve force. In fact, the want of continuity between our nerve system and what we may call that of the world is fast becoming less and less. We can already flash our ideas and our voices to the farthest parts of the earth, and the reproduction of the images of material objects by similar means seems to be in a fair way of accomplishment. But the subject of our attention to-night had its commencement in times so remote as to be far beyond the reach of human record, and its rate of progress may be measured by that of the world itself in the Arts and Sciences.

Improvements in the Arts and Sciences have gradually modified the methods of producing iron and steel; and, in their turn, the Arts and Sciences have felt the re-action; for all improvements in the manufacture of iron and steel have been not so much in the production of a better quality of article, but in the cheapening of production, by the application of the principles indicated by the progress of science, and by the use of superior machinery. The direct result of this cheapening has been to extend the applications of the products in the Arts. To appreciate this, let us glance back, and see by what means steel was produced up to the year 1855, and what were its applications, and then trace out the causes of the changes which have since taken place in these respects.

The discovery of steel appears to have naturally followed that of the means of reducing iron from its ore. In all primitive methods of iron smelting, steel, in more or less quantity, is inevitably produced. Such methods have been carried on in India and Africa from time immemorial to the present day. A similar furnace has, for several centuries, been employed in Catalonia, in Spain. The comparative cheapness of iron manufactured in other countries by improved methods, is, however, rapidly causing this furnace to pass out of use.

I propose now briefly to describe to you the process in the Catalan furnace, as it is called, in the form

into which it last developed in Spain and the South of France, in order that we may clearly understand the essential differences between iron and steel, both as regards their composition and properties, and also the conditions requisite in the production of each.

Mode of Conducting the Process.—The ore is crushed by the hammer, and divided by sifting into lumps ("mine") and very coarse powder ("greillade"). The furnace being still red-hot from the last operation, it is filled with charcoal nearly to the twyer, the hearth is then divided at a point about two-thirds distance from the twyer into two parts by a broad shovel; on the blast side a further quantity of charcoal is added, whilst that on the other side having been rammed down firm, ore is added, so as to fill that part of the furnace; on this is placed moistened charcoal dust, except at the top. A good blast is then turned on, and if the whole is in good order, jets of blue flame at once issue from the uncovered portion of the ore. After a few minutes the pressure of the blast is lowered to 1·5 in. of mercury. At intervals during the process—which lasts about six hours—the blast is gradually raised until it reaches about 3 in., the maximum usually employed.

During the whole of the process, at short intervals, "greillade" and charcoal are added, and well moistened with water, to prevent too rapid combustion. After about two hours from the commencement, the wall of "mine," *i.e.*, ore in lumps, is pushed well forward under the twyer, and more "mine" is thrown into the space thus made; this part of the process is also subsequently repeated at intervals, until sufficient has been added to form a lump of iron or *massé* of the required size. From time to time slag is removed by opening the tap-hole. At the completion of the process, a mass of metal is obtained weighing about 3 cwt., which invariably consists partly of soft iron, and partly of steely iron and steel.

Reactions in the Furnace.—We have seen that in the one part of the furnace only charcoal and "greillade" are introduced, and in the other only lumps of ore. That the ore should be in lumps at that part is a very important point, for in this way the hot reducing gas, carbonic oxide (CO), generated by the action of the blast on the charcoal, is able to pass freely through the mass of the ore, the effect of which is that the water of hydration and the moisture are first driven out by the heat, and then the ore having become easily permeable, the carbonic oxide reduces it to metallic iron, thus, $Fe_2O_3 + 3CO = Fe_2 + 3CO_2$. There are, however, several stages in this reduction, magnetic oxide being first formed thus, $3Fe_2O_3 + CO = 2Fe_3O_4 + CO_2$; and protoxide is next formed before metallic iron is obtained thus, $2Fe_3O_4 + 2CO = 6FeO + 2CO_2$, and $6FeO + 6CO = 3Fe_2 + 6CO_2$. At the same time that these reactions are going on, the ore has become impregnated with carbon, derived from the decomposition of the gases with which it is charged. That this would be the case, the experiments of Mr. Lowthian Bell and others can leave no manner of doubt.

On the twyer side, where are placed the charcoal and "greillade," the latter, as the charcoal is burnt away, descends rapidly, and, to a considerable extent, doubtless, escapes reduction, for the arrangement of the blast is such that most of the reducing gas is projected on to the lumps of ore, and does not pass up through that portion of the furnace occupied by the charcoal and "greillade," which, besides, are constantly damped. This "greillade" is much richer in silica than the larger pieces, from which it results that the quantity of slag will vary with the "greillade" added. It is always very rich in oxide of iron.

Now, what happens in this process appears to be this: carburised iron is produced by the gradual reduction and fusion of the lumps of ore, and this, coming in contact at the bottom of the furnace with slag, very rich in oxide of iron, the carbon of the one combines with the oxygen of the other, and the result is that iron containing more or less carbon is produced, according as much or little oxide was present.

The obvious conclusion would be, that the less there was of "greillade" present the more steely would be the iron; in practice this is found to be the case. This circumstance would naturally suggest the total suppression of the "greillade," when it was desired to produce steel. This would, however, be impracticable, for it is necessary that some of the oxide of iron should remain unreduced in order to flux off the silica, which occurs in considerable quantity in the ore. In the blast furnace, this difficulty is got over by employing lime; but lime at the temperature of the Catalan furnace would not produce a sufficiently liquid slag.

All that can be done, then, is to employ every available means to prevent decarburisation. Accordingly we find that when steel is required, in addition to using less "greillade," the slag is tapped out more frequently, so that the lump of iron, as it forms, may remain as little time as possible in contact with it. The bank of ore is exposed for a longer time to the reducing and carburising gases, and is pushed more gently towards the twyer, so as not to become decarburised by the air which has not had time to combine with the carbon of the charcoal. Lastly, manganese should be present. It is found that the presence of manganese has a very important influence, which is probably due to its power to replace iron in the slag. A slag containing manganese is more liquid than if it contained iron alone, and, according to François, has not the same tendency to cause decarburisation at the temperature of this process.

In order, then, that steel may be produced by this process, every precaution is taken to cause as much carburisation as possible; the unavoidable presence of oxide of iron in the slag, and the low temperature, effectually preventing the formation of cast iron; the former, indeed, making it very difficult, as we have seen, to obtain steel.

It might be said, why not increase the temperature, so as to obtain a liquid slag without using oxide of iron. If the temperature were increased, cast iron, instead of steel, would be produced; in fact, that is exactly how cast iron first came to be obtained in blast furnaces.

I have gone rather fully into this process, because the principle of it is not always well understood. Rightly looked at, it explains how steel was first obtained, and what the essential conditions are, in the production of steel. When, owing to the increased size of blast furnaces, and the

consequent increase in temperature, cast iron became the only product, it naturally followed that this substance should be treated with a view to the production of steel. This was first effected in the fining hearth, and formed an important industry in Styria, Carinthia, the Tyrol, and other places, in some of which it is still carried on.

The operation was conducted in a finery, similar in construction to those employed in the production of iron—in fact, iron and steel are often produced alternately in the same finery. This furnace, in its simplest form, consists essentially of a shallow quadrangular hearth, formed of cast-iron plates. In one side is a twyer, inclined at an angle of 10° to 15°. The bottom is kept covered with a layer of charcoal.

In the Siegen district, a piece of pig iron, weighing 50 lbs. to 60 lbs., is placed on the hearth, having been previously heated; the hearth is then three-parts filled with burning charcoal; on it is placed a portion of the cake produced in the last operation, and which has been kept hot in burning charcoal, at the back of the furnace. The remainder of the hearth is then filled up with charcoal. The other six or seven pieces into which the last cake was divided, are placed on the top. In this process the production of steel, and the reheating of that obtained in the last operation, preparatory to working it under the hammer, are conducted together. The blast is turned on. The piece of pig iron forms into a pasty mass; cinder, rich in oxide of iron, produced during the latter part of the preceding operation, is then thrown in; a second piece of pig-iron, weighing about 100 lbs., is added, and, afterwards, four or five pieces of spiegeleisen, weighing each about 100 lbs., are successively added. (Spiegeleisen is cast iron, containing manganese, in this case about 4 per cent.) If the metal is found to be too much decarburised, more spiegel is added. The cinder is usually allowed to rise 2 inches or 3 inches above the cake of metal, any excess being tapped off. There are several modifications of this process, but I have said enough to make the principle clear. In this process, as in the Catalan, it is impossible to obtain a homogeneous product. The principle in both is essentially the same, viz., decarburisation by oxide of iron. In the finery process, in addition to the oxide added in the form of cinder and scale produced during the working of the metal under the hammer, some results from the reheating, which we have seen is carried on at the same time. In this process manganese also plays an important part, and we shall see that in every process for the production of steel, manganese is used with great advantage.

With one notable exception—the cementation process—the early methods for the production of steel were simply modifications of the methods for producing malleable iron. Accordingly, we find that the introduction of the puddling process, by which malleable iron is produced in a reverberatory furnace, was soon followed by a similar process for the manufacture of steel.

The essential difference between the finery and the puddling process consists in the use of a reverberatory furnace, the manipulation of the metal and the regulation of the temperature being thereby greatly facilitated. The decarburisation is effected by the addition of oxide of iron produced during rolling, and partially by the air which enters the furnace as the metal melts slowly down; manganese is added during the process. It is important that the temperature should be kept low. It is difficult to weld this steel perfectly; this is probably due to the temperature at which the steel has to be worked being too low to make the cinder sufficiently liquid to enable it to be squeezed out under the hammer to the same extent that it is in the case of malleable iron. This difficulty has, however, been got over by completely fusing the steel before working it, so as to enable the slag to completely separate. In this form metal manufactured by this process has been largely used by Krupp. This defect is common to all steel which has been produced without fusion.

The same principle as that which regulates the production of steel by the foregoing methods is taken advantage of in the Uchatius process, which was patented in 1855.

Pig iron is first granulated by running it while molten into cold water. The granulated metal is then mixed with about 20 per cent. of roasted spathic ore, crushed fine; the mixture, to which a little flux has been added, if necessary, is then fused in clay crucibles. If very soft steel is required, some wrought-iron scrap is added.

Lastly, in this category we have a process which consists in heating cast iron, but not so as to soften it, in oxide of iron, in the form of ore or iron scale. In this way partial, or even total, decarburisation of the metal can be produced at will.

So far we have seen, then, that the difference between iron and steel is merely one of degree depending on the amount of carburisation. The methods we have considered, in fact, are only modifications of those practised for the production of malleable iron.

We will now pass to the brief consideration of the different methods of procedure for the production of steel, which, however, I think I shall be able to show naturally resulted from the observation of phenomena occurring in the first process we have had under consideration.

These processes have for their object to impart a certain amount of carbon to malleable iron. The Hindoos have practised one of them from time immemorial. They place in unbaked clay crucibles of the capacity of a pint, a piece of malleable iron, and some chopped wood, and a few leaves of certain plants; the top of the crucible is then closed with clay, and the whole well dried near a fire. A number of these crucibles are then strongly heated for about four hours in a cavity in the ground, by means of charcoal and a blast of air forced in by bellows. There is some reason to believe that an excess of carbon, over that required to produce the hardest steel, has to be added, in order to fuse the metal at the temperature which can be commanded in these furnaces. Before being drawn out into bars, the cakes of metal obtained in this way are exposed in a charcoal fire during several hours, to a temperature a little below their melting point, the blast of air playing upon them during the time. The object of this is, doubtless, to remove the excess of carbon.

In 1800 a patent was taken out by David Mushet, for a process in every respect analogous to that just referred to. He appears, however, to

have applied it to the manufacture of a metal low in carbon, and therefore intermediate between iron and steel, partaking in a certain degree of the properties of both, corresponding, in fact, to what we have referred to as steely iron. Since this metal must have been in a state of fusion, Mushet must have brought to bear upon it a very high temperature. The manufacture was conducted in crucibles.

In another method referred to by Biringuccio, in 1540, steel is produced by keeping malleable iron in molten cast iron until it became pasty, and on examination was found to possess the properties of steel. In connection with the theory of steel manufacture this process is of great interest. It shows that iron in a strongly-heated condition is capable of absorbing carbon by direct contact, unless we suppose that the carburisation is effected by dissolved gases, which is possible, for Graham and others have proved that iron can occlude gases even when it is in a solid state.

If we admit that the mutual affinity of carbon and iron, is such as to cause them to unite at the temperature of molten cast iron, it is then not difficult to conceive how the whole mass becomes carburised without the intervention of occluded gas. In asking you to concede that the surface of the iron enters into combination with the carbon in this way, I am strictly within fact, as shown by the Hindoo and Mushet processes. A marked case of this kind occurs when sulphur and silver or copper are brought together at the ordinary temperature, combination takes place.

The particles of iron at the surface having taken up carbon, their affinity would be satisfied, but the affinity of the atoms contiguous and beneath would at once come into play, and would only be satisfied by an equal division of the carbon between themselves and those on the surface.

Imagine a man carrying four cannon balls, his strength just sufficing for the task; he encounters an enemy equally strong, but who is unencumbered, and, therefore, in the possession of his whole strength.

For the sake of simplicity, we will call the man carrying the cannon balls A, and the other B. B first applies his whole strength to wrest one ball from A, and succeeds, for the chances are 4 to 1 in his favour, A holding the ball only with a fourth-part of his strength, whereas B applies the whole of his. B then tries to obtain another ball from A, and again succeeds, for the force he applies in relation to the resistance offered by A, is as 3 to 2. A and B are now on an equal footing; each is capable of taking up two more cannon balls, should the opportunity present itself.

Now, let the cannon balls be represented by the carbon atoms, and A and B by the surface and the inner contiguous particles of iron, then the bath of molten cast iron will form a reservoir from which A can re-charge itself. In the mean time other particles, C, will have deprived B of part of its carbon, just as B did A, and B will, therefore, be again in a position to obtain carbon from A.

The same reasoning would apply to each successive layer of metal throughout the mass, that on the surface taking up carbon continuously from the bath of molten metal, until, if the process were continued long enough, the malleable iron would become converted into cast iron of the same composition as that in the bath into which finally it would dissolve.

We now come to what is called the cementation process. It is not known when this process was first used. It was well described by Réaumur in 1722. In this method bars of iron are kept at a glowing red heat, surrounded with charcoal in boxes, into which the air is prevented from entering. The operation lasts from seven to ten days, according to the quality of steel required. These bars are never uniformly carburised, and, besides, they contain cinder, as the metal has never been fused. The process had been a long time in use, however, before it occurred to any one to fuse the steel and make it homogeneous. This was done by Huntsman, about 1760. It was the first time that steel had ever been intentionally obtained in a molten state, unless we except the Hindoo process, but the fused product in that case was probably too highly carburised to constitute steel. I have already premised that the addition of carbon to malleable iron, in order to produce steel, resulted from the observation of what took place in the processes first described. It was, in fact, a matter of common observation that iron, no matter whether solid or molten, kept in contact with carbon, became more or less steely. What more natural then than to endeavour to produce steel directly in this way?

By all the processes we have so far reviewed, good steel could be produced, but only in small quantity and at great expense. The applications of steel were, in consequence, very limited; in fact, practically, its use was confined to implements with a cutting edge.

In 1845, Heath patented a process which, had it been successful, would have given him the power of producing steel in quantity. He proposed to melt scrap iron in a bath of molten pig iron in a reverberatory furnace heated by jets of gas. There were two conditions wanting in this method, which caused it to be a failure, viz., a sufficiently high temperature and the power to easily regulate the character of the gases employed. Nevertheless, in this suggestion is to be found the germ of one of the two most important processes of the present day. By the foregoing remarks I do not intend to imply that the idea of mixing wrought and cast iron together to produce steel was originated by Heath. On the contrary, as we should expect, this idea was a very old one. In 1722, Réaumur tells us that he succeeded in making good steel in a common forge in this way. As far I am aware, however, Heath was the first to suggest the use of a reverberatory furnace and gas for the purpose, and that is the important point.

It may here be pointed out, that the manufacture of steel by this method does not depend by any means entirely on the adjustment of the relative proportions of wrought iron and pig iron, as appears sometimes to be thought by those not specially acquainted with the process. There is a good deal of oxidation going on during the operation, which results in the elimination of an equivalent proportion of carbon from the pig iron.

The dominant idea in treating cast iron for steel had always been to refine the metal by the action of atmospheric air, and this was effected by causing a current of air to impinge upon the surface of the metal, by means either of blowing apparatus or

the drawing action of a chimney stack. What more natural than that it should occur to someone to refine iron by blowing air into it, instead of merely on to its surface? We find that this idea did actually occur to several persons, widely separated, in the year 1855. It is a noteworthy fact that a very large number of what we call discoveries or inventions are made simultaneously and independently in different parts of the world by people who previously had probably never heard of one another.

It would seem as if the records of observations accumulated in men's minds, and in books, until they naturally pointed to certain conclusions. The man who follows up these conclusions, and applies them in practice, is not always the one who first perceived them. To carry out what appears to the world at large as new ideas, requires great strength of purpose, and such a combination of circumstances as to afford an opportunity.

In this year (1855), a patent was taken out by John Gilbert Martien, for refining iron, by forcing air through it as it flowed from the blast furnace or cupola, along runners, to the puddling furnace. This conception was a very important one in the sense that had not others been working in exactly the same direction the same time, it would probably have assisted in working out the problem involved. The process, as detailed in the patent, was impracticable, and shows internal evidence of not having been worked out on a manufacturing scale.

Just after this patent was taken out, we find George Parry, of the Ebbw Vale Works, making the experiment of forcing air through molten cast iron, on the bed of a reverberatory furnace, by means of perforated pipes imbedded in the fireclay bottom. Vigorous action is stated to have taken place, but, unfortunately for the experimentors, the metal, through an accident, escaped from the furnace, and the further trial of the process was discouraged by the managing director. There can be no manner of doubt that had this experiment been continued, very important results would have ensued. As the Ebbw Vale Company had bought Martien's patent rights, it would appear that their experiments were really based on his idea. Of this I am not, however, certain, as I am not aware of the date at which they made the purchase.

Two or three months after these experiments, Henry Bessemer took out his now celebrated patent for the production of cast steel, by blowing air through molten cast iron; it should be clearly borne in mind that he had been, for a considerable time, previously engaged on experiments on the subject.

Whether Bessemer originally started with the idea of refining pig ready for puddling, and, in the course of his experiments, made the discovery that by the action of the oxygen of the air on the carbon of the pig iron, such an enormous heat was produced that the resultant iron was obtained in a molten state—a thing never before accomplished—I do not know. The only alternative is that he arrived at the same conclusion, by inductive reasoning, which, all things considered, is very improbable.

Bessemer first carried out his process in crucibles, placed in furnaces and arranged so that the contents could be tapped from the bottom into moulds. Steam or air, either separately or together, and by preference raised to a high temperature, was forced down into the crucible through a pipe. The patent goes on to state that steam cools the metal, but air causes a rapid increase in its temperature, and it passes from a red to an intense white heat.

It was, and still is, to a less extent, an infatuation of patentees, to employ steam in the place of air. Bessemer soon discovered the essential difference which exists in practice though not realised by the excited imaginations of the majority of would-be inventors. Bessemer at first used extraneous heat to start the process, if not, indeed during its progress, which shows that he was not then aware that the heat created by merely blowing in air would be sufficient.

In his next patent taken out shortly after, however, he dispenses with the furnace round the crucible, and instead of tapping the crucible from the bottom, he mounted it on trunnions, and by tipping it up by machinery, poured the contents from the mouth. This apparatus, devised by Bessemer, is essentially the same as that used at the present day. The way in which he worked out the process in every detail to a grand practical success in such a short space of time shows him to have been possessed of a mind of great powers of conception. Having the facts before him, he drew the right conclusions from them with unerring judgment, and from one experiment passed to another suggested by it, until with indomitable perseverence he succeeded in bringing about greater progress in the manufacture of steel in a few months than had occurred in centuries before.

It was very soon found that to produce steel by this process which would work properly, manganese, if not originally present, would have to be added. In the absence of manganese, sulphur and oxygen, in anything more than very minute quantities, makes the steel crumble when worked at a red heat; it is said to be "red short." In the case of the oxygen, the manganese combines with it, and passes it into the slag; but, with sulphur, the reaction is different; its injurious effect is simply counteracted by the manganese; it is not removed from the steel.

At first manganese was only employed in the form of spiegeleisen—a variety of cast iron, containing manganese. The use of this substance was first suggested by Robert Mushet. When, however, it was attempted to produce very soft steels, a practical difficulty arose. If sufficient spiegel was added to impart the requisite quantity of manganese, then too much carbon would have been introduced. This ended in attempts being made to produce spiegel richer in manganese. By suitably adjusting the conditions in the blast furnace, this was soon easily accomplished; and instead of spiegel containing less than 10 per cent. manganese, a 20 per cent. spiegel was produced.

At the suggestion of Bessemer, attempts were made to obtain a still richer alloy. This was accomplished by reducing rich ores of manganese with cast iron in crucibles or in a reverberatory furnace. These richer alloys are known by the name of ferro-manganese. They are employed with great advantage when very mild steel is being manufactured.

By adding at the end of the process a known quantity of spiegel or ferro-manganese, containing a known quantity of carbon, steel of any required hardness could be obtained. There was but one important drawback to the Bessemer process, and that was that phosphorus was not in the least degree eliminated by it; consequently, only the best ores could be employed, which considerably increased the cost of production over that which it would otherwise have been. I will refer to that point again presently.

The year which saw the birth of the Bessemer process was doubly remarkable, for it was at that time that the regenerative system of heating was first introduced by Dr. Siemens. Nothing can be simpler than the principle involved in this method, yet it was destined to play a most important part in the progress of the arts. The idea was to store up the heat escaping in the waste gases from furnaces, and to employ it to raise the temperature of the gas and air previous to their combustion in the furnace. This was accomplished by causing the spent gases to pass through two chambers filled with loose brickwork. When these chambers have become heated to a high temperature, the waste gases are made to pass through two other similar chambers, and the air and gas necessary for combustion in the furnace are caused to pass through the highly-heated regenerators. By causing the ingoing gases to pass alternately, at suitable intervals of time, through each pair of regenerators, a very high and, at the same time, uniform temperature can be obtained in the furnace, without any greater consumption of fuel than in the older methods. The success of this process depended entirely on the fuel being first converted into a combustible gas. This was done in a chamber to which only sufficient air is admitted to convert the carbon into carbonic oxide, which is then conducted by tubes to one of the regenerators to be heated, and thence to the furnace, where, coming in contact with air which has been passed through the other regenerator, it burns, giving out intense heat. It is at once apparent that we have here the very conditions which were wanting to make successful the process patented by Heath in 1845, for not only we have the high temperature which could not then be obtained, but it has become easy to create at will, by regulating the relative proportions of combustible gas and air, either an oxidising, a reducing, or a neutral flame.

There are two methods now in use for the production of steel in the reverberatory furnace or open-hearth as it is called. In France, pig iron and scrap steel are fused together; in England, pig iron is decarburised by means of iron ore, some scrap, however, being generally added for the sake of utilising it. As in the Bessemer process, the necessary amount of carbon is imparted to the metal by the means of spiegeleisen or ferro-manganese. This process has been largely employed for the production of ship and boiler plates. It has the great advantage that the metal can be kept fluid on the hearth, and its composition adjusted until it is exactly that required.

In 1876, a patent was taken out by M. Pernot, in which it was proposed to produce steel on an open-hearth furnace with a revolving bed, inclined at an angle of 5° or 6° to the vertical. Pig iron previously heated to redness is placed in the bed of the furnace and covered with scrap steel. The bed of the furnace is then made to revolve slowly, the pig gradually melts, and the scrap is alternately exposed to the strong heat of the flame, and then dipped under the molten pig iron. In this way the fusion is very rapid comparatively, the whole mass becoming fluid in about two hours. The process is then completed in the ordinary way. When repairs are necessary, the bed on its carriage is drawn out.

In practice, it is found that these furnaces require very frequent repairing. With the view to make this easier, M. Pernot has arranged a movable roof, which has besides the additional advantage of reducing somewhat the strain on the structure occasioned by such great variations in temperature. M. Pernot informs me that he has just taken out a patent for an arrangement of his furnace by means of which he can employ gas under pressure, and that within the last few months he has obtained by this means results which have never been equalled before. He states that, in a seven-ton furnace, he has obtained five charges in twenty-four hours. This, at any rate, contrasts favourably with the figures given by Hackney, in 1875. He says five charges, of about four and a-half tons each, are got out in each twenty-four hours; the coal used being about eight to eight and a-half cwts. per ton of steel. The averages obtained with furnaces of similar design, and working under similar conditions, but with fixed beds, he states to have been just about half, and the coal used per ton of steel to have been eighteen cwts. Mr. Holley, of New York, has recently stated that they are getting with the ordinary Pernot furnace a seventeen-ton charge in six and a-half hours, all cold stock, except five tons pre-heated scrap.

The Steel Company of Scotland tried the Pernot system and abandoned it. They appear to have come to the conclusion that, owing to the great trouble and expense in keeping the furnaces in repair, the system possessed no special advantage over the ordinary Siemens furnace. If I am not mistaken, however, the Steel Company of Scotland were using these furnaces for soft steel for ship plates, whereas, in the instances referred to, rail-steel was being manufactured. This is an important difference, the temperature in the former case requiring to be much higher than in the latter, the carbon being less, and the metal, therefore, more infusible; consequently, the wear and tear and attendant expenses would be proportionately greater. Be that as it may, it is beyond dispute that this system has achieved a considerable measure of success abroad, which will probably increase, as modifications, such as I have referred to, are gradually effected to reduce wear and tear, and facilitate repairs.

We now come to the Ponsard furnace. It aims at combining the advantages of the Bessemer and open-hearth processes. The furnace is so arranged that, by giving it a half revolution on its oblique axis, the twyers with which it is supplied may be brought either beneath or above the surface of the bath of metal. By these means the metal can be rapidly decarburised nearly entirely, as in the Bessemer converter, and

then, by removing the twyers from beneath the metal, the final adjustment of the carbon can be made as in the Siemens process. The only difficulty experienced in working out this idea to a practical success appears to be the rapid destruction of the twyers. This obstacle is certainly a very great one, and it may possibly be found insurmountable.

It may here be remarked that some firms in France, and, indeed, in England, too, claim to be able to produce steel of any required composition and characteristics with equal exactness by the Bessemer process as by the Siemens. There can be but little doubt that much can be done in this way by the Bessemer process where the work is systematically and carefully carried on.

Notwithstanding the fact that phosphorus cannot be eliminated in the ordinary Bessemer converter, enormous quantities of steel have been made by this process, and within the last two or three years means have been devised by which this bugbear of steel-makers has been overcome. I refer to what is known as the Thomas-Gilchrist or "basic" process.

In the ordinary Bessemer converter the lining is formed of ganister, a siliceous material. Now, silica has a greater affinity for oxide of iron than phosphoric acid has, consequently, so long as free silica is present phosphoric acid cannot remain in combination with oxide of iron; whilst, then, the lining of the converter was of silica, it is sufficiently obvious that phosphoric acid could never be eliminated.

You will at once say, why line the converter with this objectionable substance? The answer is easy—no substitute was known, and the reason why phosphoric acid was not removed was not generally understood.

This was the state of things when Messrs. Thomas and Gilchrist commenced their experiments. The object they had in view was to substitute for the ganister a basic material, such as lime. The difficulty they had to contend with was to obtain a lining which would hold together. After many failures and much patient labour, a material has been found which fulfils the necessary conditions. This material is magnesian limestone; by grinding it and mixing it with pitch, bricks can be formed, which, after burning, are very refractory. In lining the converter it was impossible to cement the bricks satisfactorily together; they generally get a good deal curved in baking, and fit badly together, and the cementing material is easily washed out by the molten metal. In order to get over this difficulty, the converters have been lined by running the material in, and then drying and heating in stoves the various pieces of which the converter is composed. This method has proved to be more successful.

From an enemy, by judicious treatment, we may be said to have converted phosphorus into a friend. In the acid process, it is essential that about 2 per cent. of silicon should be present, for it is, to a great extent, due to the presence of silicon, that the requisite high temperature can be obtained. In the basic process, the less silicon there is the better; because it destroys the lining by fluxing it away. Here it is that the phosphorus befriends us, for it, too, is capable of producing a high temperature by combining with oxygen; and that being the case, it becomes possible to work with about half the silicon necessary in the acid process, which practically means that we may employ a much lower grade of iron; for the lower the grade of iron, the smaller will be the amount of silicon in it.

So appreciated has this hitherto despised substance become, that it is actually the practice to put back into the blast furnace a great part of the slag from the converter, in order to increase the amount of phosphorus in the pig iron, subsequently to be converted into steel.

There is, however, a limit to the lowness of grade of iron which can be used, for, although the silicon decreases, the sulphur increases, and only about half the sulphur present in the pig iron can be removed in the converter. One-tenth per cent. of sulphur suffices to prevent steel from rolling in a sound condition. As I have already pointed out, the way to counteract the influence of sulphur is to employ manganese in sufficient quantity, but this is not without a drawback, for manganese is expensive.

In working out this process, much difficulty was at first experienced, owing to the mouth of the converter getting gobbed up, that is to say, stopped by projected slag. The basic slag, consisting as it does principally of lime, is very pasty. This inconvenience has been successfully got over by employing converters of the form shown on the diagram. It was predicted by many, that the slag and metal would be thrown out of the mouth of this form of converter; but that has not been the case, and it is not improbable that eventually this shaped vessel will be universally adopted for both the acid and the basic processes. Such is already the case at Messrs. Bolckow, Vaughan and Co.'s works, where, under the intelligent and persevering guidance of Mr. Windsor Richards, the basic process has first been made a commercial success in this country.

One word as regards the silicon, which, we have seen, is useful as a combustible in the Bessemer process. This substance produces both red and cold shortness in steel, which has to be worked, if present, in even so small a quantity as two-tenths per cent. But in the production of sound steel castings, it has been found to exert a very beneficial influence by preventing the metal from becoming honey-combed by escaping gases while solidifying. It exerts its influence by combining with oxygen, which would otherwise unite itself to carbon, and form a gaseous compound; the silica thus produced passes rapidly into the slag in combination with manganese, which is introduced at the same time as the silicon in an alloy containing them both.

In consequence of the extremely high temperature which we can command, either in the Bessemer or open-hearth processes, it is possible to obtain in a molten state metal practically free from carbon, or containing carbon to any required amount. It is sufficiently obvious that, having regard to the original and commonly understood meaning of the word steel, some other name should, strictly speaking, be applied to all metal manufactured by these processes, which cannot be hardened and tempered. In practice, however, there are many obstacles in the way of this being done, and it has become customary to designate by the term steel all the

metal which has been produced in a molten condition by the Bessemer or open-hearth furnaces.

It thus has resulted that we speak of steel ships, steel boilers, and steel rails. The metal of which ship plates are made contains about $\frac{13}{100}$ths per cent. of carbon, that for boilers about $\frac{24}{100}$ths, while rails usually have about $\frac{4}{10}$ths. The first and the second could not be appreciably hardened, and the third is considerably below what would formerly have been considered steel.

Although, then, metal possessing the true characteristics of steel can be made by these processes, yet that which is ordinarily made is not steel, but a metal called into existence by our recently acquired power of obtaining an extremely high temperature.

This new metal, as we may fairly call it, has properties far excelling those of wrought iron, and it has only been a question of time to make this universally felt.

At the present moment new iron rails are things of the past, and wooden sleepers have begun to follow in their wake, it having become apparent to all that our new metal will be an economical substitute. So with ships, the wooden walls of old England are no more. Steel has not only supplemented wrought iron where it was used, but the wood also.

At present there is but one sound reason why steel should not universally replace iron with advantage, and that is, that in some cases it is cheaper to employ iron. Statistics show us that the enormous quantities of steel now manufactured have but little, if at all, affected the production of wrought iron. It is, however, I am convinced, but a question of time. When the day comes, and every day brings us nearer to it, when steel will be manufactured as cheaply as iron, then will wrought iron be a thing of the past amongst the great civilised nations.

One word as regards the employment of steel made by these modern methods for cutlery. Cutlery manufacturers would tell you that it is useless for the purpose; nevertheless, on the Continent, it is very largely used, and in this country to a considerable extent. I do not hesitate to assert that, with suitable ores and proper care in the manufacture, steel well suited for cutlery can be made both in the open-hearth and the converter. The essential in the ore is that it should not contain phosphorus; with but a trace of phosphorus present, a good cutting edge could never be obtained.

I have endeavoured to show you this evening in what progress has really consisted, and how it has been brought about. If we glance back for a moment, we see that the open-hearth processes embody the same principle as the first process by which steel was produced, viz., the mutual action of carburised iron and oxide of iron on one another, and the Bessemer process is, after all, though a splendid offspring, only the natural descendent of the finery process, the origin of which, as we have seen, was due to modifications in the primitive blast furnaces. There is perfect continuity throughout, and, after all, what more natural? Progress in the art of manufacturing steel has been the joint work of the scientific chemist and the engineer. As in the past, so in the future, success will depend upon these two elements working harmoniously together.

DISCUSSION.

Mr. Michael Scott remarked that, within the limits Professor Huntington had given himself, they could hardly have had a more complete sketch of steel manufacture. He would venture to say, with regard to the Bessemer process, that as James Watt left the steam-engine practically perfect, so Mr. Bessemer deserved credit for having left, not only his process practically perfect, but all the appartus required in connection with it. They were even now reverting to some of his old arrangements of machinery, finding they were better and more simple than those which had since been invented and applied. With respect to the use of manganese, it was objected to as being expensive, but he thought there was another and still more important reason why it should be used in moderation. Dr. Siemens, on one occasion, mentioned it very properly as being, like charity, a thing that covered a multitude of evils. But it only covered the evils, and he had reason to believe it did not remove them. Not very long ago, he saw some specimens of steel which had been exposed to the atmosphere for two or three months, and the scaling was something perfectly alarming. He made inquiry with respect to the composition of the metal, and the only thing he could find which could account for it was an excessive dose of manganese. Manganese had been very useful, and it was very important, but it had been used to rather too great an extent. With regard to the Ponsard and Pernot furnaces, they had not yet been very successful in England, where the two great processes of Bessemer and Siemens were preferred. One important advantage claimed was that the time would be reduced for producing a charge of steel. No doubt they could produce steel in less time; but, on the whole, the simple furnace shown in the diagram, for Siemens's process, was still supposed to be the best. With regard to the Bessemer process, he had seen steel of the very highest quality produced by it. He believed, as the reader of the paper had said, that it could be produced for cutlery or for any other purpose, but it did require very careful attention. At present the Bessemer process seemed to have taken the chief part of the rail trade, and the Siemens process the chief part of the plate trade, when the amount of carbon was extremely low and the tests extremely high. Some observations had been made as to the recent improvements in steel, the progress had been so rapid that it was not only a question of years or even months, but practically of weeks and days. During the recent meeting of the Iron and Steel Institute, in London, some matters of a startling character had been brought forward, so that those interested in the subject required to keep their information up to the latest possible date. No reference had been made to the diagram on the wall which he believed represented Dr. Siemens's latest improvement in gas-producers. Perhaps it would be rather too technical to go into it, but so far as he understood, it had been a great success. It certainly seemed to have the elements of success in it.

Mr. Shoolbred said he should like to ask Professor Huntington, who he believed had carried out a series of experiments with regard to this material called "steel," to give some information as to its capabilities for constructive purposes. To himself and to many others that branch of the subject was becoming of great moment. The question of the importance of the vast range of this substitution of steel for iron had not been unduly dwelt upon, since there was scarcely any branch where iron was at present used where steel was not rapidly taking its place. On the other hand, in many instances which had come within his own knowledge of structural use, the expense attending the construction of steel in the ordinary forms of angle, T, or double T, required for joists and so on, even taking its greater strength into consideration, had

generally proved to be prohibitory. They were told that possibly the price might be brought down; but a few days ago he had occasion to ask one of the largest makers, and he found that such was not the case at present. With regard to the Siemens's regenerative furnace, it might perhaps be interesting to mention how very largely they had come into use in the industrial arts generally; in fact, it meant the use of fuel in the gaseous instead of the solid state. A short time ago he had occasion to make some inquiries on that head, and it was pointed out to him that in the year 1879, probably no less than $3\frac{1}{2}$ million tons of coal in the United Kingdom were converted into gaseous fuel, by means of this regenerative furnace, in various branches of industry. That showed how largely the use of gaseous fuel was growing; and not long ago, in that very room, there was an interesting discussion on the question of using gaseous fuel in domestic arts, in order to get rid of London fog and smoke.

Mr. F. Maxwell Lyte said it might be interesting to start a discussion on the question of the honey-combing which occurred in Bessemer steel castings. The subject had caused a deal of discussion, and yet there never seemed to have been any satisfactory explanation given. It had been said that silicon or silicide of iron being added to the metal, caused a decomposition of the occluded gases therein contained, but this would appear to be not quite the case. But it seemed to him that the carbon, which was capable of deoxidising silica under certain circumstances, at this high temperature, would have a tendency rather to de-oxidise any slag which might be contained, than to have its oxygen withdrawn from it, and so to produce a silica which passed into the slag. Was it not at least equally possible that, under those circumstances where silicon or manganese were added to the metal, that there might be produced a kind of alloy, incapable of occluding gases which would be occluded by a purer iron? They knew that one pure metal, silver, for instance, was capable of occluding oxygen gas, which it would not do when alloyed. Perhaps some gentlemen present who had knowledge on this subject, would be able to throw some light on the question.

Mr. J. S. Jeans said he should like, as one who had bestowed some consideration on the manufacture of steel, to add a few words of congratulation to what had already been said on the very excellent paper they had heard. If there was any defective part about it, it was, perhaps, the absence of any specific information as to the results of the processes which had been described, in their statistical, commercial, and industrial aspects. It might be interesting, therefore, if he mentioned the fact that, about 25 years ago, the total quantity of steel produced in the world was under 100,000 tons. That was previous to the invention of the Bessemer process. Last year, the total quantity of steel made by the Siemens process and the Bessemer together was over 4,000,000 tons. These figures would convey some idea of the enormous progress which had been made in the interval, and of the great industrial development that these processes had contributed to bring about. He did not quite agree with Mr. Huntington, in thinking that the application of steel in the future would be such as to completely displace iron. It was never wise to prophecy unless you happened to be aware of the facts, but, having had occasion recently to inquire into that matter, he found that in the six iron-producing countries in the world after Great Britain, the production of the manufactured iron had, within the last ten years, increased by 30 per cent. Of course, that increase was nothing like commensurate with the increase which had in the same interval taken place in the manufacture of steel, but it was sufficient to encourage the idea that for a great many years to come, at all events, manufactured iron would continue to hold its own. He remembered an ex-president of the Institution of Civil Engineers remarking, not long ago, that, in his opinion, before many years were over, for all purposes except the ordinary working of a blacksmith's forge, steel would be used in place of iron. But they were evidently a long way from that as yet. There was no doubt that, however good the qualities of steel might be, there still remained a great many prejudices to be overcome, and recent occurrences, with which most of them were familiar, were likely to retard its progress considerably in the near future. That these difficulties would ultimately be surmounted nobody would for a moment doubt, but, at the same time, there could be no question that a great deal yet remained to be accomplished by the chemist, the metallurgist, and the engineer, before they found a metal which for all purposes, and under all circumstances, was perfectly trustworthy. He should have been glad if the Professor had shown amongst the many interesting diagrams illustrating his paper the fixed converter, which was adopted at Gefle, in Sweden, at a very early stage of the Bessemer process. He believed that there were still in operation in Sweden some fixed converters, and that on account of the great purity of the pig iron used in that country, Bessemer steel was there made without the use of manganese. They were given to understand, by no less an authority than Dr. Siemens, that it was quite within the bounds of possibility, if not already an accomplished fact, that very good steel, even the best, might ultimately be made entirely without manganese, which Dr. Siemens had described as being simply a cloak for imperfections. In the Bessemer process, however, there was no doubt that a great deal remained to be accomplished before that was attained. He should also like to hear some details concerning the manufacture of puddled steel. Even to the present day that was a considerable industry in some parts of Germany, and also in Austria and France, though he was not aware that any puddled steel was now made in this country. It was, of course, not employed to anything like the same extent as the steel made by the Bessemer and open-hearth process, which, for all practical purposes, might be regarded as the only two processes of the future. It was rather largely due to the failure that took place in connection with the application of puddled steel to ship building, that steel had not been sooner used for that purpose. Some thirty years ago a boat was built for Dr. Livingstone of puddled steel, and the Doctor sent an account of the results obtained to the Society. He found, as might have been expected from the process of manufacture, that it was a material more akin to wrought iron, laminated and heterogeneous, than to the homgeneous ingot metal with which they were now familiar, and the results of its application did not realise expectations.

Mr. Scott said there were essential differences between steel and iron. Steel was a more obdurate metal to work, and, consequently, could not be worked so cheaply as iron. In addition to that there were other considerations; steel shafting running in iron was said to cut into it; therefore there would always be disadvantages connected with its use for some purposes.

Mr. Clements, with regard to a remark made that steel would eventually be used for almost every purpose for which iron was used, said he thought that in the construction of roof trusses, cast iron would continue to be used, perhaps for ever, where there were strains of compression. He did not know exactly what the compression of steel was, but he knew the force of compression of cast iron was very great indeed. Malleable iron, cast iron, and steel, each had qualities of its own, and would be used for special purposes. He believed the Bessemer steel was very well suited for ordinary purposes, for rails and

other forms in which steel was required in the form of mass, and that Siemens's steel was more adapted for plates. With regard to honey-combing, he thought that was produced from the condensation of occluded gas, because there was no doubt that when metals were in a heated state, carbonic anhydride and oxide were present, and as the metal cooled, the gas would also cool and leave vacant spaces. The same thing was found to occur on a large scale in nature, in minerals thrown out by volcanoes. The Thomas-Gilchrist process appeared to be the greatest discovery lately made for removing the phosphorus from the steel, as made in the Bessemer or other processes. It seemed to him that there were now few discoveries yet to be made with regard to the monufacture of steel, which had arrived almost at a state of perfection, and that in the future the perfection of the metal would be more due to manipulative processes by which small quantities of impurities might be got rid of.

Mr. Joseph Gordon said, with regard to the observation made about bringing the price of iron and steel more nearly together, from what the president of the Iron and Steel Institute stated last week, it would be confessed that the prices, as far as rail metal went, were as nearly as possible together now. Taking into consideration the difference made in the tests of iron and steel plates in ship building, he did not think consumers could very well ask steel-makers to come down to the extremely low prices before paid for ordinary iron plates. In that direction, he did not think any *rapprochement* could be expected, though he trusted it would be possible to reduce the absolute price of steel in future, when the commoner ores which were found in England could be used with the expensive ores got from abroad.

Professor Huntington, in reply to Mr. Scott, said that, as regards manganese, the same remark would apply to it as to anything else; it was possible to have too much of it. If you found metal which was imperfect, which, on investigation, contained too much manganese, it was not a thing to be surprised at, when you remembered manganese was used in every process by which it was produced. Manganese was used in every process in the production of steel. It was used equally in the crucible process, by which the finest cutlery ever produced was manufactured, and in the Bessemer and every other process. Unless Mr. Scott could suggest some means of getting good steel without manganese, he feared they must continue to use it. With regard to the Ponsard and Pernot furnaces, he brought them forward because the paper was to be on the recent processes in the manufacture of steel, and they might fairly look upon them as being at any rate in the direction of progress. It was impossible to say until a process had been in use some years that it was a commercial success; there were many difficulties to be overcome which required a considerable amount of time, and an expenditure of a great deal of brain power. It required hundreds or thousands of men to be working at a process before it was brought to perfection. These processes, to his mind, had certain portions about them which might ultimately cause them to be successful. Beyond that neither he nor anyone else could speak with certainty. With regard to the use of steel for constructive purposes, no doubt it possessed very great advantages, and like everything else new, required to be studied and understood. In order to use steel satisfactorily, it was necessary that the architect should know something of the properties of the metal he was dealing with, and adjust the proportions of the metal in his structure accordingly. He had not gone far into the question, but from what he understood generally there could be little doubt that steel for the purposes of construction should undergo some modification in form, the properties of the metal being difficult to those of wrought iron. If those who were engaged in the arts of construction would give the metal a little attention, he thought a large amount of good would result. It was not sufficient simply to reduce the section in all parts of a complicated piece of metal work. As regards honey-combing, he had attempted to explain what was generally considered to be the cause of the removal of honey-combing as found by those who had experimented on the subject. As regards the alloy which Mr. Maxwell Lyte had suggested as a cause of the removal of honey-combing, he could not agree with it, for he saw no reason to suppose that an alloy would not occlude gas, when a metal would; because they knew from the experiments of Graham and many others, that all metal occluded gas, in fact, all fluids did so, even the bottle of water before him, if frozen suddenly, would show a mass of bubbles of air throughout. All fluids took up gas, and as the pressure and the temperature changed, so would a greater amount of gas be occluded, or given off. Mr. Jeans had rather taken him to task for not giving statistics, but he could only say that he had filled up the hour allotted to him, and when he had written down that much, he felt he should have exceeded his duty to write more. There were many other matters he should like to have mentioned, but it would have necessitated detaining the meeting for a week. The figures mentioned by Mr. Jeans were no doubt interesting, and they could be found by anybody on referring to the proceedings of the Iron and Steel Institute. He appeared to be of opinion that manufactured iron would hold its own. He believed it was a question of time, and the prices coming down. As improvements were made and time went on the price would come down, and then steel, which he did not think any man conversant in the two metals would deny was infinitely superior to iron, would replace it. Although fixed converters had held their own in Sweden, wherever new ones were put, one similar to that employed in Europe generally was used, showing that fixed converters were practically things of the past. Mr. Jeans was not quite accurate in referring to the purity of the pig iron used in Sweden preventing the necessity of using the manganese, because it already contained sufficient for the purpose. He had not time to refer to the puddled steel further than he had. He would only say in conclusion, that steel was a metal absolutely and indisputably superior to iron, and could be used for every purpose for which wrought iron was now used.

Mr. F. Maxwell Lyte wished to explain, with regard to his previous remark, that they knew that several pure metals were capable of dissolving gas to a considerable extent, whereas alloys of those same metals were not. One per cent. of copper would totally prevent silver from dissolving oxygen, which it took up in a very large quantity when in a perfectly pure state, and so would one, or even a half per cent. of gold. Palladium, by being alloyed in the same manner, was prevented from absorbing hydrogen. He only threw out the suggestion whether an alloy being formed between iron and manganese might possibly prevent the absorption, or cause the expulsion of the gases, and he thought it was worth investigation.

The Chairman said Professor Huntington had given, in a most lucid manner, an account of the recent points in the steel manufacture. It was impossible to deal, in the space of an hour, with a subject which would fully occupy many lectures, without omitting a point here and there which would have been interesting to all. In connection with this very subject—honey-combing—for instance, he had not referred to the interesting and important result obtained by Sir Joseph Whitworth on the compression of steel; but it was impossible, in the time at his disposal, to have dealt with the whole subject more comprehensively. That steel had made enormous strides they must all admit, but they had much to learn; they were, in fact, not yet quite in accord with each other as to what steel

really was. Mechanical engineers and chemists had for years been engaged on the question of the definition of steel, and he believed every one would admit there was no satisfactory definition yet. Again, with regard to the varieties of steel and the extraordinary physical modifications which it underwent when subjected to the action of heat under different conditions, or the effects produced by hardening and tempering, they might be almost said to know nothing. It was to gentlemen like Professor Huntington, who dealt scientifically and practically with these subjects, that they looked with confidence to make important contributions to the knowledge of the manufacture, of the conditions which would insure a uniform manufacture of steel, and of the proper methods of applying it. He would conclude by moving a cordial vote of thanks to Professor Huntington for the excellent manner in which he had brought the subject under their notice, and the large amount of food he had given them for reflection.

The resolution was carried unanimously.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 18th, 1881; F. J. BRAMWELL, V.P.Inst.C.E., F.R.S., Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Armitage, William James, Farnley-house, Chelsea, S.W.
Brebner, Robert Charles, 10, Henry-street, Carlisle.
Britton, Percy Wilson, 14, Augusta-road, Ramsgate.
Johnson, Thomas Hilton, F.C.S., 36, Rawcliffe-road, Rice-lane, Walton, Liverpool.
Lloyd, Alfred, B.A., Bush-lane, Cannon-street, E.C.
Walker, Philip F., 29, Prince's-gate, S.W.
Young, Charles Edward Baring, 12, Hyde-park-terrace, W.

The following candidates were balloted for, and duly elected members of the Society:—

Bonar, Lionel Ninian, 57½, Old Broad-street, E.C.
Butler, Lieut.-Col. Henry Thomas, 66, Prince's-gate, S.W.
Campbell-Walker, Capt. Arthur, Ashley Warren, Walton-on-Thames.
Gibbs, Sir B. T. Brandreth, 13, Pelham-crescent, South Kensington, S.W.
Hudleston, Wilfrid H., M.A., F.C.S., F.G.S., 23, Cheyne-walk, Chelsea, S.W.
Lee, Charles John, Fairlight-villa, Sydenham-road, Croydon.
Nesbit, A. Anthony, F.C.S., 38, Gracechurch-street, E.C.
Nevill, Lady Dorothy, 45, Charles-street, Berkeley-square, W.
Stirrat, Robert B., 7, Grey-street, Newcastle-on-Tyne.
Walkinshaw, William, Hartley-grange, Winchfield, Hants.

The paper read was on—

ELECTRIC RAILWAYS AND TRANSMISSION OF POWER BY ELECTRICITY.

By Alexander Siemens.

When electricity was first utilised for practical purposes, the cost of producing it precluded its application to anything but giving signals or working small and delicate apparatus, requiring only weak currents to perform their functions; but by the discovery of the dynamo-electric principle, some fourteen years ago, powerful electric currents have been placed at our disposal, at a cost which enables us to transform into commercial processes a number of experiments which, up to that time, served only as illustrations of scientific lectures.

The machines which have caused this revolution in the application of electricity consist essentially of two parts—the fixed electro-magnets, by which a powerful magnetic field is created, and the revolving armature, which is connected with the commutator. When the machine is in action, the rapid motion of the copper wire through the magnetic field induces an electric current, which leaves the helix by the brushes pressing against the commutator on opposite sides. From the brushes the current passes to the electro-magnets, and afterwards to the outer circuit, where it has to perform the useful work. In traversing the coils of the electro-magnets, it increases the intensity of the magnetic field, which in its turn induces a more powerful current, and this mutual strengthening of current and magnetic field goes on until a balance establishes itself in the manner afterwards described.

The researches of Sir William Thomson, Dr. Hopkinson, Professor Ayrton, and others have proved that such machines, if properly constructed, will render in the form of electrical work up to 90 per cent. of the energy expended upon them in the form of motive power. It may, therefore, be conceded that they are very efficient transformers, and that we can hardly hope to exceed the results already obtained by the best types of dynamo-electric machines. If, instead of using such a machine to generate electricity you send a current into it, the magnetic attraction created between the poles of the electro-magnets and the currents traversing the armature will cause the latter to rotate, and this motion can be communicated to other machinery in the usual ways. A pair of such machines, one for producing electricity and the second for re-transforming the current into motive power, can therefore be utilised for transmitting power to a distance. In order fully to understand the manner in which this transmission is effected, a large number of experiments were made at the works of Messrs. Siemens and Halske, in Berlin, by Dr. Frölich, and the results obtained were laid before the Royal Academy of Science in Berlin by Dr. Werner Siemens on the 18th November, 1880.

The principal conclusions arrived at were the following:—On applying Ohm's law to a magneto-electric machine (a machine with permanent magnets) we find that the strength of current for a given total resistance is—

$$(1.) \qquad C = \frac{n \times M \times v}{R}$$

In this formula C signifies the strength of current; n, the number of convolutions of wire on the armature; v, the number of revolutions per minute; R, the total resistance in circuit; M, the total E.M.F. produced by the permanent magnets and the iron of the armature in one convolution of wire, when $v = 1$; this quantity will afterwards be called "effective magnetism" of the machine.

The same formula holds good for a dynamo-electric machine. In this case, however, the "effective magnetism" (M) depends on the

strength of current (C), and the formula, by substituting f (C) for n (M), becomes—

$$(2.)\qquad C = \frac{v f(C)}{R}; \text{ or } \frac{C}{f(C)} = \frac{v}{R}.$$

In the latter form, the very important law is expressed that the strength of the current in a given dynamo-electric machine depends only on the ratio of the number of revolutions per minute to the total resistance in circuit. If we determine, therefore, f (C) for a machine, we can calculate beforehand the strength of current it will produce with a given number of revolutions in a given resistance.

The first series of experiments was made to test the correctness of this conclusion, and the curves I., II., and III., embody the results obtained by working one of the largest "Siemens'" dynamo machine (type D_0.) through various resistances at diffierent speeds. The total resistance of the machine was, in case (I.), ·435 S.U.; in case (II.), ·725 S.U.; and, in case (III.), 7·14 S.U.

By way of comparison, the curve IV. was set out from results published by Messrs. Meyer and Auerbach in "Wiedemann's Annalen," Band 8, p. 494, who had experimented with a "Gramme" dynamo machine. As will be seen, all these curves do not differ materially from a straight line, and, for the limits of practical working, they fully confirm the above theory. There exists, therefore, a curious similarity between magneto-electric and dynamo-electric machines. In both, the strength of current is proportionate to the ratio of revolutions per minute to total resistance, although the magnetism of the magneto machines is a constant quantity, and that of the dynamo machines varies with the strength of current. The important difference between the two kinds of machine is, that magneto machines give a current however slow their motion is, whereas dynamo machines only begin to give a current when the ratio of number of revolutions to total resistance attains a certain magnitude.

The nature of the f (C) was then further examined, and the influence on the magnitude of the "effective magnetism" of the currents set up in the iron of the armature by its quick rotation in a magnetic field, and by the currents traversing the coils of the armature. The results arrived at are represented by the curves V., VI., VII., for the large Siemens machine, and by the curve VIII. for the Gramme machine referred to above. They show that at first the "effective magnetism" increases in proportion to the increase of current, then it deviates more and more until it very gradually reaches a maximum, and for still more powerful currents it decreases again. The latter peculiarity is to be accounted for by the fact, that the iron bars of the electro-magnet cannot be magnetised beyond a certain point, whereas the diminishing influence of the currents on the magnetism in the iron of the armature increases continually with the strength of these currents. In practical applications such powerful currents are seldom met with, and it will suffice for the present purpose to assume, that the "effective magnetism" gradually approaches a maximum.

When two machines, identical in their construction, are connected to transmit power, the "effective magnetism" in both should be equal, as the same current circulates through both of them. The following equations will, therefore, exist between the various quantities:—

$$E_1 = n\,M\,v_1;\ E_2 = n\,M\,v_2;$$

$$C = \frac{E_1 - E_2}{R} = n\,M \times \frac{v_1 - v_2}{R};$$

$$W_1 = a \times E_1 \times C = a\,C^2\,R\ \frac{v_1}{v_1 - v_2};$$

$$W_2 = a \times E_2 \times C = a\,C^2\,R\ \frac{v_2}{v_1 - v_2};$$

$$H = a \times C^2 \times R;\ W_1 = H + W_2;$$

$$N = \frac{W_2}{W_1} = \frac{v_2}{v_1} = \frac{E_2}{E_1}.$$

In these formulæ the index 1 refers to the machine producing the current, and the index 2 to the machine giving out the power; E stands for electro-motive force; n, M, v, R, C, signify the same quantities as before; a is a constant depending upon the construction of the machines; H is the heat, generated in the system; W_1 is the work expended upon the primary machine; W_2 is the work given out by the secondary machine; N is the useful effect.

In comparing these formulæ with observations, it is easily seen that they cannot be quite correct. This is most conspicuous with the formula for the useful effect, $N = \frac{v_2}{v_1}$, according to which this should be greatest the more the velocity of the second machine approaches the velocity of the first machine, whereas actual experiments show that N is a maximum for a certain velocity of the second machine, and will decrease for any greater or lesser number of revolutions of the secondary machine. The cause of this discrepancy is the influence of the so-called Foucault's currents, which are set up in the iron of the revolving armatures by the proximity of the powerful electro-magnets.

In the primary machine these currents circulate in the same direction as the currents in the covering wire of the armature, and by weakening the "effective magnetism," and, consequently, the E_1M.F — E_1, they increase the work W_1 expended upon the primary machine. In the secondary machine, however, in which the armature turns in the opposite direction, these Foucault currents circulate in the opposite direction to the currents of the armature wires, and by thus strengthening the effective magnetism and the electromotive force E_2, they diminish the work W_2, given out by the secondary machine.

As our machines are supposed to be of identical construction, the following formula will express the relative proportion of the different quantities relating to the Foucault currents:—

$$M_1 = M - ec_1;\ M_2 = M + ec_2;$$

$$c_1 = \frac{M_1\,v_1}{u} = \frac{1}{n}.\frac{E_1}{u};\ c_2 = \frac{M_2\,v_2}{u} = \frac{1}{n}.\frac{E_2}{u};$$

M signifies the effective magnetism, such as it would be, if no Foucault currents existed; M_1 and M_2, the actual effective magnetism of the two machines; c_1 and c_2, the strength of the Foucault currents; u, the resistance through which these currents circulate; v and n, having the same meaning

as before; and e being a constant, depending on the construction of the machines.

If we calculate from the above equations the value of M_1 and M_2, substituting at the same time $y = \frac{e}{u}$; we have:—

$$M_1 = M(1 - y\, v_1)\,;\; M_2 = M(1 + y\, v_2)\,;$$

and for the electromotive force of the two machines—

$$E_1 = n\, M_1\, v_1 = n\, M(1 - y\, v_1)\, v_1\,;$$
$$E_2 = n\, M_2\, v_2 = n\, M(1 + y\, v_2)\, v_2\,;$$

this gives us for the current—

$$C = \frac{E_1 - E_2}{R} = \frac{n\, M}{R}\left[v_1 - v_2 - y\,(v_1^2 + v_2^2)\right];$$

and for the work expended and given out respectively—

$$W_1 = an\, CM_1\, v_1 + ac_1\, M_1\, v_1\,;$$
$$W_2 = an\, CM_2\, v_2 - ac_2\, M_2\, v_2\,;$$

or if we substitute $p = \frac{a}{n_2 u}$:

$$W_1 = a\, CE_1 + p\, E_1^2\,;\; W_2 = a\, CE_2 - p\, E_2\,;$$
$$N = \frac{W_2}{W_1} = \frac{E_2}{E_1}\left[\frac{1 - p\,(E_1 + E_2)}{aC}\right];$$
$$H = a\, C\,(E_1 - E_2)\,;\; F_1 = p\, E_1^2\,;\; F_2 = p\, E_2^2\,;$$
$$W_1 = W_2 + H + F_1 + F_2.$$

In these formulæ the symbols have the same signification as before, and F_1 and F_2 signify the work done by the Foucault currents.

The electrical quantities E_1, E_2, and C admit of an easy measurement, and by the help of the above formulæ, the quantities W_1 and W_2 can be determined beforehand, when the constants of the machines are known.

A great number of experiments were then made, in which all the quantities were measured, and the observed results were compared with the quantities calculated from the above formulæ, and it was found that they agreed very well. It is hardly necessary to observe that these formulæ are applicable to all types of dynamo-electric machines, whatever their construction may be, the character of each type determining the constants.

The idea of utilising these machines for transmission of power presented itself to Dr. Werner Siemens as long ago as 1867, when he discussed at the Paris Exhibition with other members of the jury the possibility of elevated electric railroads; but the dynamo machine was at that time not sufficiently developed to admit of a practical execution of the idea, and when the present more perfect forms were invented electric lighting monopolised for a time all the attention that was bestowed upon the practical application of the machines.

During the efforts which have been made to introduce electric lighting on a large scale, the idea of applying the light-giving machines during daytime to distribute power, has come to the front again, and as such an application means a further utilisation of the invested capital, the combination of lighting with transmission of power is sure to be made.

For this purpose a central station has to be established in a district, in which powerful steam-engines, working on the most economical principles, drive a number of dynamo machines, which produce the electric currents. Secondary batteries, similar to those constructed by M. Planté, and improved by M. Faure, may be employed to receive the electricity, and keep it ready for use in the same manner as the gas is stored in large gas-holders, and as accumulators are used in connection with hydraulic machinery.

From the station cast-iron pipes are laid through the streets, similar to those now in use for distributing gas or water, and insulated wires are drawn into them for conveying the currents from the machines to their destination. At convenient intervals the wires are made accessible by so-called "road boxes," inserted in the pipes, from which the connection to houses or lamp-posts can be made. Two separate sets of wires would be required for the lighting and for the transmission of power, the commutators, for directing the currents, being placed in the station; and additional commutators could be fixed in the houses for switching the current from secondary machines to lamps, without communicating with the station.

There is, no doubt, that much has to be learnt before all the details of such a central station, and of a practical system of distribution have been brought to perfection; but there are, nowadays, few obstacles that cannot be surmounted, and even our present knowledge is advanced enough to teach us that there is nothing impossible in the idea sketched out above.

When a certain amount of power has to be transmitted by electricity to the given distance, it is easy to determine, experimentally, what power is required to drive the primary machine, as the exact conditions, under which the trial was conducted, can be readily reproduced in the practical application. In this respect, the transmission of power by electricity possesses a great advantage over the transmission of power by water or air, as the friction and leakage of the pipes, through which the latter have to be conducted, can never be determined in advance. It further has the advantages that the secondary machine works without producing any waste, which has to be disposed of, and that the small size and low weight of the machines obviates the necessity of heavy foundations for them.

In considering the possibility of employing the electric current to distribute power from a central station, the proportion of the power given out by the secondary machine to the power expended upon the primary machine, will not be of that deciding influence, as is generally supposed. Granted even that not more than than 45 per cent. of the power expended can be reclaimed, it will still be possible to produce the power required at a cheaper rate, than if each small place had its own steam-engine. For, at the central station, 1 h.p. could be produced by the large steam-engines with about $2\frac{1}{4}$ lbs. of coal, so that 1 h.p. given out by the secondary dynamo machine would be produced by burning 5 lbs. of coal per hour. There are few small steam-engines which will produce a horse-power with that expenditure of fuel, and if we take into account the trouble and risk connected with the running of steam-engines, it may be readily admitted that this loss is no real obstacle to the introduction of the electrical transmission of power. Of still less consequence will this loss be

where waterfalls or other natural forces can be employed to drive the primary machines, in which case the power would cost practically nothing, beyond the interest on the capital and the depreciation of the machines. The applications which it has hitherto found have, to a certain extent, been of a tentative nature only, and on a small scale, but they are nevertheless very instructive, as they show that economical results can be obtained by it.

About three years ago, Sir William Armstrong erected a turbine at his country seat, Craigside, near Newcastle, and drives by it a Siemens dynamo-electric machine, the current of which is conducted to his residence about half a mile distant from the waterfall. In day-time this current transmits the power of the turbine to the house, where it is used for various purposes, and at night it is converted into light by means of "Swan" lamps, of which it works between thirty and forty. This application deserves special mention, because it is one of the earliest examples of transmission of power by electricity for practical and permanent purposes.

In the same way Dr. Siemens utilises some dynamo machines at his country house near Tunbridge-wells, the power to drive the primary machines being, in this case, obtained by means of a Tangye "Soho" steam-engine. The waste steam from the engine is utilised to warm the hot houses, and the gardener attending the houses takes also care of the steam-engine and the dynamo machines driven by it. In this way the cost of fuel and of attendance is reduced to a minimum.

The electric current is utilised during the whole of the night to produce two lights, by the influence of which various fruits and plants are growing; and the current, in daytime, from one machine sets in motion a similar machine, which works the chaffcutter, and some other machinery, at the farm about a quarter of a mile away from the hothouses. The current from the other machine is conducted to the pumping-house, a distance of about half a mile, and the secondary machine there has supplanted a small vertical steam-engine that used to pump the water up to the house. In this case, the return conductor is formed by the wire fence, care being taken to connect the wires from one side to the other of the intervening gates.

By these arrangements, one man at the farm can do the work of three; and, instead of a man having to drive a steam-engine at the pumping-station, to say nothing of transporting coals there, and losing time in getting up steam, he can set the pump in motion without going near the place, an occasional visit only being required for refilling the lubricators.

There are many similar instances, in which it is advantageous to connect a number of small machines, which work at irregular intervals, by means of the electrical transmission of power with one steam-engine, not only when the distance between the machines is considerable, but also when they are comparatively close together.

Several applications of the latter nature have been made at Messrs. Siemens's works at Charlton; among others the apparatus for testing the mechanical strength of cables, is set in motion by a dynamo machine; and a small pump, which keeps the water in circulation in the core-tanks, is driven by another machine. In both cases it would have been more costly to transmit the necessary power in the usual way by shafts and belting. A few months ago a machine was placed upon a crane on the wharf, and it was found that by it a ton could be lifted about 12 feet per minute, and smaller weights proportionately quicker. It is only fair to add, that the crane was not constructed for the purpose, and that the arrangement was made more with the view to demonstrate the possibility of working cranes by electricity, than to obtain the best results.

The electrical transmission of power, on account of the compactness of the machines, and the ease with which the conducting cables can be shifted, is particularly adapted to be used in cases where the driven machinery is erected only for temporary purposes. As an example, it may be mentioned that, when the cable ship *Faraday* was last at the works of Messrs. Siemens, the machinery, by which the cable is pulled on board, was driven part of the time by a dynamo-electric machine.

Another illustration of the same kind was furnished by M. Felix, of Sermaize-les-Bains (Marne), who worked, in June, 1879, one of Howard's double-furrow ploughs by a Gramme dynamo machine. The motion was conveyed from the electrical machine to a drum, and thence by a coil of wire to the plough. There was no stoppage of any kind, but the plough did its work steadily, digging up the ground to the depth of about eight inches. In the following year, M. Felix showed at the local agricultural exhibition at Bar-le-duc a plough and a threshing machine, both worked by electrical transmission of power, with perfect success.

As mentioned above, one of the first thoughts of Dr. Werner Siemens was to employ dynamo-electric machines for working elevated railroads, but it was only about three years ago that he was induced to take the matter into serious consideration, by the owner of a coal mine asking him to design a locomotive to draw the coal waggons in the mine. The result was that Messrs. Siemens and Halske showed at the Berlin Exhibition, in the summer of 1879, the model of an electric railway, which has since been exhibited at Düsseldorf and Brussels, and is at present working in the Crystal Palace. The total length of this circular railway was at Berlin 300 metres, and the gauge one metre. A dynamo machine, mounted on a carriage by itself, served as locomotive, and the passengers were conveyed in three carriages, each having seats for six persons. The current was conveyed from the primary machine to a rail laid between the rails on which the carriages run; thence it was taken off by brushes fixed to the machine and sliding on the centre rail, it returned to the primary machine by the outer rails. When the carriages were prevented from moving, the locomotive exerted a pull of about 4 cwt. (200 kilos.) on them; and when the train was in regular motion, the pull varied between $1\frac{1}{2}$ cwt. and $1\frac{3}{4}$ cwt. (70-80 kgr.), which represents, as the speed was about 10 feet (3 metres) per second, three-horse power.

Small as the railway was, it clearly demonstrated that such a mode of transport is feasible; and the advantages of having light carriages, of being able to propel them without noise and smoke, induced Messrs. Siemens and Halske to lay before the authorities in Berlin a plan to make an elevated

railway through one of the streets in Berlin, altogether about $6\frac{1}{4}$ miles (10 kilom.) long.

Along the kerbstones of the street, iron columns, formed by two-channel irons, were to be erected, about 11 yards apart, carrying wooden sleepers on top, which, in their turn, support longitudinal girders. To ensure the stability of the structure, wooden struts keep the girders apart, and serve, at the same time, to insulate them from each other. The clear height, from the level of the street to the under side of the girder, is about 14 ft. 6 in. (4·4 metre), and the depth of the girder about 16 in. (40 cm.) Steel rails are laid on top of the girders, and the girder and rail on one side serve as the conductor from the primary machine, and the other rail and girder form the return wire; in this way the electrical resistance of the line is reduced to a very low figure.

The gauge of the line was to be one metre, and the carriages, resembling ordinary tram-cars, were to be about 5′·5″ broad (1·65 m.) and 8 feet (2·46 m.) high above the rails. The dynamo machine, placed out of sight, underneath the car, imparts the motion by means of belts to the two wheels, which have to be insulated from each other, as the current arrives through one rail, passes through the machine, and returns by the other rail as described above.

The speed at which these carriages were intended to travel is 30 kilometres (18·6 English miles), and ten of them were to be supplied for the railway, of which six would be in use, and four in reserve, 10 h.-p. being required to drive the primary machine of each carriage. The cost was carefully worked out, and, as it serves as an indication what such railways may be expected to cost, a short summary of the principal items will not be out of place.

First cost of 10 *kilometres* ($6\frac{1}{4}$ *miles*), *elevated railway, single line.*

Railway itself, including 10 stations..........	£61,000
Ten carriages, to hold 15 persons each	3,150
Stationary steam-engine and dynamo-machine	1,950
Buildings	1,185
Land	4,500
General expenses	715
	£72,500

or about £11,600 per mile.

This estimate includes the cost of erection of the railway, and of the station, at which the steam-engine works, together with the necessary buildings to protect the rolling stock against the weather, when it is not used. The cost of working the railway was calculated to be, for one year:—

Current Expenses.		
Wages..........................	£2,190	
Fuel............................	1,110	
Oil and waste......................	50	
Lighting.........................	80	
		£3,420
Depreciation and Repairs.		
3% on £62,500 (railway and buildings)	£1,875	
16% on £5,000 (carriages and machinery)	800	
		£2,675
Interest on Capital.		
5% on £75,500		£3,625
Total cost per annum..................		£9,720

or about £4 6s. per English mile per day.

The intention was to run about 200 trains per day, and if the charge of 1d. per mile had been made, the £4 6s. per mile could have been earned, if on the average five or six persons had been conveyed in each case. The concession for this railway was not granted, partly because the inhabitants strongly objected to having people looking into their first floor windows, and partly because the Emperor did not wish to see "The Linden," which this electric railway was to cross, disfigured.

Subsequently, Messrs. Siemens and Halske obtained permission to build a railway on the ground level from Lichterfelde, a suburban station on the Berlin-Anhalt Railway, to the Military Academy, and this railway has just been successfully opened for regular traffic. It is a single line of 1 metre gauge, a little over $1\frac{1}{2}$ English miles long. The permanent way has been constructed in exactly the same way as that of railways; wooden sleepers and steel rails are employed, the rails being connected, in addition to the usual fish plates, by short straps of iron, bent in the shape of a bridge, so as to admit the adjustment of the rails to different temperatures, and to reduce at the same time the electrical resistance. As the currents are low tension currents, it was not necessary to provide further insulation, and no difficulty is experienced in using one rail as the positive, and the other as the negative conductor.

About a third of a mile from the Lichterfelde station the primary machine, with its steam-engine, is erected in the engine-house of the water-works, and the current is conveyed from there to the rails by underground cables. The car is exactly similar to an ordinary tram-car, and is constructed to hold 20 persons besides the guard. It is symmetrical, and can move backward and forward, each end being provided with a starting lever for the guard, a brake handle, and a signal-bell. The dynamo machine is placed underneath the car, and transmits its movement to the wheels by means of spiral steel springs. The tires of the wheels are insulated from their axles, and are in electrical connection with brass rings, fastened on the axles, but insulated from them. Contact brushes press against these brass rings, and from them the current is conducted to the dynamo machine, and sets it in motion.

The authorities were, for some time, doubtful how to class this novel railway, and after long deliberation they have decided to rank it as a one-horse tram-car. In consequence of this decision, the average speed on the railway must not exceed 9·3 English miles (15 kilometres) per hour, and the greatest speed at any moment must not exceed 12·4 English miles (20 kilometres) per hour. The time for traversing the whole distance is, therefore, not to be less than ten minutes, although the car could make the journey in about half the time with perfect safety.

If the railway continues to work in a satisfactory manner it is to be extended, and there is no doubt that the success of the railway at Lichterfelde will greatly assist in the further introduction of electrical railways, either on the level of the streets, or elevated, like the steam railways of New York. Over any other system, worked by steam or by compressed air, the electrical has the advantage that no heavy machinery has to be carried about to set the train in motion. The

carriages can, therefore, be built in a lighter manner, thus reducing the power necessary to move them, and permitting all bridges and other superstructures to be built more cheaply than usual. Several carriages, each with a dynamo machine, can be joined to one train, and by this distribution of the motive power much steeper inclines can be overcome than when the same train is drawn by a single locomotive.

In addition to the ordinary brakes, means can be provided to short circuit the machines on the carriages, and to cause them in this way to act as very powerful brakes. The use of large stationary engines reduces the amount of fuel necessary to develop a certain power on the travelling carriage, and if waterfalls can be utilised, the cost of working these railways will be further diminished. It seems, therefore, probable that such railways can be usefully and economically constructed to facilitate the traffic in crowded streets, or in situations where local circumstances favour their application.

From all that has been done during the last few years, it is quite evident that the art of transmitting power by electricity has advanced rapidly, and that its practical application is continually gaining ground. This, however, should not be regarded as a sign that the electric transmission will supersede every other system of transmitting power to a distance, but rather that there is a sphere for it, where it meets existing demands better than our present means; and it should, therefore, not be treated as an enemy of existing systems, but as a supplement to them, by the aid of which problems can be solved, that could not otherwise be attempted.

DISCUSSION.

The Chairman said the subject brought before them that evening was one which, though of the highest importance, had been presented in a modest unassuming manner; but there was in the paper matter for very deep consideration. The great utility of some means of transmitting power to a distance had long been recognised, and must be appreciated by all who thought on the subject. The same argument was frequently made use of which had been advanced to-night, that if power could be laid on to houses in small quantities, it might turn the course of industry from the system of large factories to a system in which each workman might work in his own dwelling; but he was not at all prepared to say that such a change, except in special cases, was desirable. The probability was that the workman would have bad ventilation, that he would not attend to his duties so well as he would in a large factory, and that all the economies arising from a well-organised establishment and the sub-division of processes would be done away with, the only advantage being the somewhat sentimental one, that the man worked in his own house. However, this was rather a question for the political economist than for an engineer. Attempts at transmitting power from a distance had been made for many years. He was apprenticed to an engineer (John Hague) who was the very earliest to make the attempt on a large scale. His mode was the exhaustion of air by pumps worked by water-wheels or other suitable prime movers, the exhausted mains being connected to engines in the nature of a steam-engine, and the pressure which the atmosphere exerted on the piston caused it to work. In that way power was conveyed very well indeed—considering the time at which it was done—and very usefully. Notably, it was conveyed to underground engines in coal mines, where it provided a motor free from the objections of steam-engines in such positions; it was also conveyed from a steam-engine into gunpowder manufactories, so as to obviate the necessity of fires within the manufactory. Since then they had had the transmission of power by compressed air, and also by water under pressure, as perfected by Sir William Armstrong, by means of accumulators and various hydraulic engines. He could not quite agree with Mr. Alexander Siemens, that the great advantage in the electric mode of transmission over these last two, lay in the fact that with them the loss by friction and leakage could not be accurately calculated; because the loss by friction was easily calculated, and that by leakage was dependent on the care with which the work was carried out, and it ought to be, and was in fact, extremely small. Then again, there was the transmission of power by means of endless ropes, of which there was a magnificent example at Schaffhausen, where the water of the Rhine was made to work large turbines which drove endless ropes; these were carried about three-quarters of a mile along the bank of the river, and drove shafting under the side streets, from which the power was laid on to various houses, and he did not know a more interesting sight than to see the power of the Rhine thus utilised. But this evening we had before us a means of transmitting power by electricity, and no doubt if such a slender conductor as was on the table could be substituted for the large exhausted main of John Hague, for the smaller main carrying compressed air, or the still smaller one carrying water under pressure, or for the rope running over guide pulleys, a great step would be gained. Mr. Alexander Siemens had put it that this mode would be economical even supposing only 45 per. cent. of the power developed in the steam-engine was available at the spot where it was utilised, and did so, on account of the greater economy in working one large central steam-engine, rather than a number of small ones, and in that he quite agreed with him, as also in the statement that $2\frac{1}{4}$ lbs. of coal per h.-p. was a liberal allowance for a large condensing engine, and that at least 5 lbs. were used in small non-condensing engines. He had also pointed out that where water-power was available, it might be utilised in a manner which it could not be at present, as, instead of factories having to be built in inaccessible, out of the way places, the dynamo machines could be placed there, and connected by wires to sites where the manufactures could be carried on with comfort, and where transport was easy. He had had the good fortune to see the arrangements of Sir William Armstrong, at Craigside; there was a fall of water which drove the machine, the wires were led to the house nearly three-quarters of a mile off, and during the day the force was employed to work a saw bench, and at night for illuminating the house. He had not been there since the Swan lights were introduced; but Sir William Armstrong wrote to him a couple of months ago, saying that the lighting had been much improved since he saw it. Sir William stated that the light was perfect, so much resembling daylight that, at the time of writing, he had even been obliged to get up and draw the curtains, because there was a thrush outside trying to commit suicide by coming through the window. It appeared that the authorities at Berlin did not know how to classify this new railway; but their putting it down as a one-horse tram-car reminded him of a curious classification he heard of not long ago, when he visited the celebrated cavern near Trieste. This was lit by candles, and the landlord of the hotel complained that the electric light had been proposed, but the Prefect objected, citing a resolution which had been passed by the authorities, that neither aluminum, electricity, nor any other smoke-producing means of illumination should be employed. With regard to another mode of using electric force, which had been touched upon in the paper, he might say that he had

had all the evening a most agreeable perfume coming from a melon on the table before him, which Dr. Siemens had grown by the sun, aided by electricity; and he had no doubt it would prove as good as other fruits he had tasted from the same source. In this paper they had the opening out of a subject, the importance of which it was difficult to exaggerate. If, by means of electricity, they could practically convey power to a distance, and give it forth when required in anything like a reasonable proportion of the power originally employed, it was perfectly certain that they had thereby a means of utilising the forces of nature, which now were wasted. All round England they had a sea which ebbed and flowed with varying range, but probably the average would be about 15 feet; and if they could, by means of water mills, utilise that enormous tidal force, and transmit it electrically to centres of population, they must economise the coal now employed for the purpose of motive power, and reserve it for those purposes for which, up to the present time, it would seem that coal was needed, viz., for metallurgical and other similar purposes. At the same time he by no means despaired of hearing that it was no longer needed directly even for these operations, for it was beginning to appear that electricity was able to do that, in the way of melting refractory materials, which had hitherto been done by the expenditure of fuel. The subject of the paper was so large and important, that he thought it would not be too much to ask the Council of the Society to devote next Wednesday evening to a continuance of the discussion.

Professor Ayrton said the first point which occurred to him on hearing the paper, was in connection with the formula by which Mr. Siemens arrived at the result that the efficiency of electrical transmission ought to reach the maximum when the velocity of the motor was equal to that of the generator; but who went on to say that there seemed to be something wrong in this theoretical conclusion, because it was not borne out by experiment, and the explanation given was the Foucault currents which were set up by induction in the iron. He ventured to think there was another explanation altogether which would account for the formula not according with experimental results, and indeed he should not have predicted that the formula would agree with the results. He presumed that the experiments to which they referred were made with dynamo machines, in which the current generated by the machine was used to excite the field magnets. Now, supposing they had two dynamo-electric machines, one driven by a steam-engine, and producing a current, and the other producing work by means of that current, and imagine them running at exactly the same speed, what would be the result? There would be no current whatever passing the wire joining them; because, if running at the same speed, the electro motive force of the generator must be equal and opposite to that of the motor. But if there was even little current passing between the two machines, it was impossible for the second machine to receive power at all, since there could be no magnetisation of the field magnets. And yet for the motor to revolve rapidly work must be spent in friction, even if no useful work were given out; hence it was really the use of dynamo machines which caused the theoretical result to differ from the practical. The machines which ought to be used were either dynamo-electric machines with separate exciters, or else magneto-electric machines. For the transmission of power efficiently and economically it was absolutely necessary that the magnetisation of the field magnets should not be produced by the current passing through the wires joining the two machines. But when such an arrangement as he referred to was carried out, there would be little difference between the theoretical and practical result. It would be found that the economy of the transmission increased as the velocity of the motor more and more approached that of the generator; and when both velocities were extremely high, and nearly equal, the efficiency would approach very nearly to 1. There were various considerations which would bear this out. If you made experiments, as his students had done, with magneto-electric machines as motors, measuring the electric energy put into the magneto-electric machine, and at the same time measuring the amount of work given out by it, you did not find that there was a maximum point after which the efficiency diminished. All the experiments he had seen showed that the efficiency increased with the speed; and he had actually obtained with a very high speed an efficiency of 92 per cent. He thought, on the whole, the conclusions Mr. Siemens had arrived at tended to show what Professor Perry and himself had advanced several times, that they ought to use either magneto-electric machines or dynamo machines, with separate exciters; and, to a certain extent, this conclusion was borne out by practical experience, because he learned that in electric lighting, which was but one mode of transmitting power, it was becoming the practice to use separate exciters for the dynamo machines; and that was the method adopted by Dr. Siemens in the City. As the Chairman had pointed out, the great advantage of electricity as a means of transmitting power was not that the friction and leakage inseparable from other methods could not be calculated; but experiments seemed to show that electricity had no mass; that there was no inertia in it; and there was no waste of power in making it go round a corner, as there was with water or any kind of material fluid. In many respects, of course, the flow of electricity through a wire was like the flow of water through a pipe; the quantity of current was constant, and the electricity lost potential, just as water lost head; but there was this great difference between the two, when you had to make water go round a bend you lost a great deal of power, and the form of the bend made a considerable difference. If you had two or more bends in a pipe, in opposite directions, you lost more power than if there were a continuous curve in the same direction; but this was not so with an electric conductor, since bends made absolutely no difference in the electric resistance of a wire. The Chairman had alluded to the great advantage which would result from an enormous quantity of waste power being utilised, and with that he concurred, not so much with regard to the tide, the utilisation of which he feared lay in the dim future, in consequence of the great expense of storing the water when the tide rose, but rather with regard to the water-power of streams. It was quite lamentable to walk about the neighbourhood of Sheffield and see the number of old grindstones which formerly were worked by water-power, now lying idle, the grinders having all gone into Sheffield, where they used grindstones worked by steam-power, which cost them more; but they saved, on the whole, on account of the expense of transportation. If those streams could be used to work magneto-electric machines, from which the power could be conveyed into the town, and there utilised, it would be an immense advantage. There was another point about electric railways which might not have struck some of those present. At present locomotives weighed from 40 to 60 tons, necessitating very substantial and expensive bridges and permanent way, and it was impossible to make them much lighter, or they would not have sufficient adhesion on the rails to pull a train; you could not much diminish the weight so long as you drove a train by one or two pair of driving wheels. But if you drove the train by nearly all the pairs of wheels, as could easily be done electrically, it might be made comparatively light, and there would be no loss by slip. The great value of the paper lay in its technical character; it was a laudable example of the application of principles of science to practice, which characterised all the work of the Messrs. Siemens; and if he had ventured to differ a little

from some small part of the theoretical considerations advanced, he would conclude by assuring the meeting that no one more highly appreciated its practical bearing.

Mr. J. N. Shoolbred said he had made some experiments on the transmission of power, and was much struck by the remarks of Professor Ayrton on the amount of useful power the formulæ disclosed, and also as to the nature of the machines which, in his opinion, would have to be employed. He agreed with him as to the errors, which had probably arisen from the use of two dynamo machines, one as the generator and the other as the motor. He had himself long seen reason to doubt the ordinary statement that there must be a loss of 50 per cent. in the second machine, and he hoped, by some means or other, they would be able to discover the proper formula. With regard to the two classes of machines, spoken of by Professor Ayrton as the best form of primary machines, either magneto machines or dynamo machines with separate exciters, he thought—especially where the same machines were used for lighting and for transmitting power in the daytime—that dynamo machines would be chiefly employed; but they would generally fall under the condition of having one common exciter, and, consequently, according to Professor Ayrton, about 80 per cent. of the original duty given off might be recovered.

Professor Ayrton wished to explain that the figures he had used, and which were quoted in the paper, did not mean that if you gave a certain amount of power to the dynamo-electric machine you could get out 90 per cent. of that in the electric light produced by that machine; it only meant that 90 per cent. of the power given to the machine was reproduced as electric energy. Some of that energy was employed in producing light, but a large portion—often nearly half, or more—was employed in heating the wires or the magnets.

Dr. C. W. Siemens, F.R.S., said he would only make a few remarks that evening, and speak more at length when the discussion was resumed next week. Professor Ayrton had remarked that the dynamo machine would be superseded by the magneto machine, or by a dynamo machine with a separate exciter, and he confessed that he went a long way with him in his argument; indeed, last year he communicated a paper to the Royal Society in which he showed certain defects in the dynamo machine, and suggested certain remedies. The dynamo laboured under this defect, that, with an increase of work, the power to overcome the resistance diminished. The current produced by the rotation of the coils in the magnetic field had to excite the coils of the magnet itself, and the current then passed on to the second machine or to the light, to the place where the work was to be performed. Now if that work should present increased resistance, the machine which had to overcome it should increase in energy, whereas the greater resistance caused a weakening of the current and a falling off in the power of the magnets by which the current was produced, thus causing those fluctuations which were so troublesome in electric lamps, but which, by different arrangements, had been almost overcome, and would be entirely overcome by the aid of further experience. It was quite true that in the City they were working with dynamo machines having separate exciters, but the dynamo machine could be so arranged that a portion only of the current was set aside to excite its own magnet, and if that arrangement were properly applied, he believed all the advantages of a separate exciter could be secured with a single machine. The subject especially before them, however, was the application of electricity to the propulsion of railways and the transmission of power, of which the propulsion of carriages was only one branch. Several other methods by which propulsion could be effected might be mentioned. Only a few days ago he had been in Paris, and had arranged for the construction of a short line of comparatively broad gauge, which was to be carried out by the omnibus company of Paris, in connection with the Electrical Exhibition. An ordinary tram-car would be run from the Place de la Concorde to the Exhibition, upon rails laid in the usual manner, having a suspended conductor along the side of the railway. This conductor would have a little carriage passing along it, in order to transmit the electric current from the suspended wire to the machine, and back through the rails themselves. That arrangement, which was devised by Dr. Werner Siemens, made them independent of partial insulation of the rails upon which the carriage ran, and also independent of the partial insulation of the wheels of one side from the other, leaving the rolling stock very much the same as at present, transferring the current to a separate conductor, something analogous to a single wire telegraph, upon which the contact roller ran and conveyed the current to the machine. Another arrangement by which an ordinary omnibus might be run upon the street would be to have a suspender thrown at intervals from one side of the street to the other, and two wires hanging from these suspenders; allowing contact-rollers to run on these two wires, the current could be conveyed to the tram-car, and back again to the dynamo machine at the station, without the necessity of running upon rails at all. He merely mentioned this to show that the system was not one which must be carried out in one particular way only, but was capable of very wide modification and extension according to circumstances. The paper referred to certain applications which he had made of electricity, near Tunbridge-wells, to horticulture, and on the table was a melon which had been produced by the aid of the electric light. He hoped the Chairman would take it home, and report upon it next week.

The Chairman said if it turned out as good as other electrically-grown fruit which he had tasted, his duty would be far from a disagreeable one. He then declared the meeting adjourned until Wednesday next.

MISCELLANEOUS.

BRUSSELS INTERNATIONAL EXHIBITION.

This Exhibition, due to private initiative, was started with the object of receiving foreign products and inventions which were not admissible at the purely national exhibition in the Champ des Manœuvres. The Palais du Midi, which was originally built for a market, was completed with a special view to its present destination, and formally opened by the King and Queen of the Belgians, accompanied by Sir Savile Lumley, the British Minister, on 1st June, 1880. It was intended to be permanent; but the great falling off in attendance during the winter months has induced the committee of management to terminate the present exhibition with its first year of existence, and on 1st June next to open the first of a series of annual exhibitions, from June to October, with special classes, varying each year.

The classes fixed upon for the present year are:—1. Carpets of all kinds, including felt, mats, and india-rubber; 2. Tapestry and other fabrics connected with furniture, including American cloth; 3. Upholstery, curtains and hangings; 4. Works of the decorator, including plaster of Paris, carton-pierre and papier-mâché; 5. Shawls; 6. Lace and tulle; 7. Military trimmings and embroidery; 8. Dress and its accessories; 9. Ceramic ware, both porcelain and pottery; 10. Glass and crystal ware; 11. Window and stained glass, mirrors, &c.; 12. Art bronze, zinc, and iron-work; lighting and heating appliances; 13. Goldsmiths' work;

14. Jewellery; 15. Arms and cutlery, including surgical instruments; 16. Musical instruments; 17. Cabinet work; 18. Art joinery and parquetry; 19. Decorative sculpture and marble work; 20. Travelling and miscellaneous objects: 21. Artificial flowers; 22. Usual applications of the arts of drawing and wood-cutting, including mechanical drawings, lithography, chromolithography, engraving, photography and phototypy; 23. Wall-paper, including imitation leathers, writing paper, and office requisites; 24. Clocks, watches, chronometers, pedometers, clepsydræ and sand-glasses; 25. Specimens of typography, autographic proofs, new works and editions, periodical publications, atlasses, art buildings, printing ink and accessories; and 26. The various machines employed in the above classes.

The Commissioner is M. B. F. Pasquier, engineer; and the Administrative Council comprise MM. Felix Tasson, Wynand-Janssens, H. Weber, Alfred Brasseur, and Charles Washer; the engineer is M. Th. Devadder, honorary engineer of the Belgian State Railways, who designed the buildings at the Exposition d'Hygiene in 1876. Further information may be obtained from, and all goods should be addressed to, the General Manager, M. Ernest de Bavay, Palais du Midi, Brussels.

Several objects in the Exhibition, now about to close, present features of industrial, humanitarian, or sanitary interest.

An interesting demonstration of the saving of substances which have hitherto been allowed to pass away to waste, is afforded by a collection shown by the Société Anonyme des Produits du Flénu, Belgium, of the subproducts obtained in their process of coke making. There are some excellent specimens of tar, ammoniacal liquor, benzole, benzine, various light oils, heavy oils for preserving timber, naphthaline, anthracène, pitch, liquid ammonia, &c.

The Exhibition contains some new applications of iron, both wrought and cast. The Compagnie des Forges d'Aiseau show some hexagonal pavings, which they make by pressing out sheet iron into moulds, giving them a pattern, and at the same time a deep flange, so as to cause them to keep their place when imbedded in sand. M. Leopold Gilquart, of Labuissière, shows a similar application for roofing purposes. He presses out the sheet iron into the form of roofing tiles for overlapping each other; and some of them are provided with a small pane of glass. A new industry has lately sprung up in Belgium, that of enamelled wrought-iron ware for superseding crockery; it has the disadvantage, however, that a fall causes the enamel to fly off at the spot where the article has struck. The Société des Fonderies et Emailleries show a case containing representative samples of the new ware, which is ornamented with patterns like earthenware, from which it can scarcely be distinguished by sight. M. Perrody, of Geneva, exhibits some paving-blocks consisting of a hollow cast-iron shell filled with concrete, and also some tramway chairs made in the same manner. Some of the latter have been taken up after service, and are broken to show the fracture. The same inventor also shows his system of insulating underground telegraph wires. He makes small cylinders of enamelled earthenware, pierced with holes in the direction of their length. The wires pass through these holes, and the cylinders are protected and kept in place by lengths of cast-iron tubes, divided longitudinally and horizontally for ease of laying.

A new method of reproducing industrial drawings, which is said to be greatly superior to the prussiate of potash "blues" that have lately become common on the Continent, is exhibited by M. Ad. Joltran, of Paris. The copies are produced by the aid of the sun acting on "*papier gommo-ferrique;*" and the lines appear of an indigo tint on a white ground, with all the clearness of the originals.

A model, one-tenth real size, is shown of some temporary wards which have been put up for cases of infectious diseases at the Hôtel Dieu, Châtelet, designed by Dr. Gallez. They are isolated by a system of passage, the two sides of which are closed by framework, but can be left open, if desired, so as to allow the free access of air. The framework is of 1-inch pitch-pine, varnished, and made double, so as to enclose spent tan, saturated with a solution of sulphate of iron, for preventing any danger of infection to other patients. The wards are warmed by the ventilating stove of the Société, H. J. Piron et Cie, of Hodimont Verviers, which produces an active ingress of fresh air, and is so constructed, that the warmed air does not come in contact with the furnace. Mr. F. V. Mouly, of Brussels, shows his "Calorifère atmosphérique et hydrothérapique," which permits of simultaneously warming and ventilating an inhabited building, a green-house, and a place of public *réunion*, while supplying hot water for the baths and lavatories. The heating surface warms the air, combined with water for hygienic considerations; but the flues, uniting in a single chimney, also contribute to warm the building and draw off vitiated air, being surmounted by a special aspirator. Mr. E. G. Banner was awarded a gold medal for his ventilators, some new forms of which are exhibited; while it was practically demonstrated that the wind, blowing with average velocity through a one inch-cowl, is capable of drawing foul air through 72 feet of one-inch india-rubber tubing.

M. Systermans contributes a full-sized section of railway carriage filled with his safety appliances for the protection of the guards when passing from carriage to carriage. A belt, passed round the guard's waist, is attached by a swivelling spring catch to a ferule, which slides along a continuous handrail, attached to the offside of the carriage. The ferule is so arranged as to clear the fastenings of the hand-rails, which are connected from carriage to carriage by a jointed rod, so as to afford uninterrupted communication. Mr. W. Brenton, of St. Germans, received a silver medal for his safety door and window fastenings; he also shows some traction springs, made by Messrs. Fairholme and Co., of London, for facilitating the start of tram-cars, railway trucks, and other heavy vehicles drawn by horses.

The engine driving the machinery in motion is supplied with steam by a system of safety boiler, which was designed by M. De Nayer, papermaker, of Willebrock, for his own use, but is now becoming generally used in Belgium. The boiler is composed of tubes, in which the steam is generated, connected by wrought or malleable iron receivers. Two tubes form an "element;" and these are in turn connected by short tubes with conical joints, perfectly tight, without any cement or packing. The small diameter of the tubes, and the great strength of the materials employed, render this boiler practically inexplosive; but if, through any unforseen defect in the metal, a tube should give way, the explosion would be confined to that tube, and produce none of those disastrous effects attending the bursting of ordinary shell boilers. The evaporation is from eight to nine pounds of water per pound of small coal. M. J. Barbe, of Brussels, exhibits his additional safety valve, which he applies to the under-side of ordinary boilers for preventing explosions. Messrs. A. H. Bateman and Co., of East Greenwich, who were awarded a bronze medal, show, among other objects, their safety boiler fittings, consisting of—(1.) A new safety valve, in which three spiral springs are substituted for a single large one; a lever is added for raising the valve off its seat from time to time, to make sure that it has not set fast, and when once adjusted to the required pressure the engineman cannot alter it, although the working parts are perfectly visible. (2.) A new water-guage, in which, on the glass breaking, all escape from the boiler is at once prevented, thus obviating the danger of scalding so common on locomotives. (3.) An improved steam sentinel, which gives warning, by whistle, of an excess of pressure, having a lever added to prevent the valve

from remaining fast on its seat. (4.) An improved conical form of fusible plug, for preventing explosions, owing to deficiency of water.

Life-saving on the water was represented by Messrs. C. W. Meiter, of London, with Colonel de la Sala's folding boats and rafts; and M. Verhaaren Rowet showed his safety air-tight cans for holding volatile and inflammable substances.

FAURE'S SECONDARY BATTERY.

Considerable interest has lately been aroused by the announcement that a Paris electrician has discovered a new method of storing electricity. The invention is really a new secondary battery, or, rather, an improvement on the well-known secondary battery of M. Planté. A secondary battery, it is hardly needful to say, is one which is charged by the action of a battery, or machine, and then gives out this charge as required.

In the Planté battery the electrodes are of lead, and they are immersed in acidulated water.

In M. Faure's battery the two lead plates of the couple are each covered with minium (red lead) or another insoluble oxide of lead, then enclosed in felt, kept in place by lead rivets. These two electrodes are then put side by side in a vessel of acidulated water. If they are very long, they are rolled up like those of M. Planté. Thus constructed, the couple is charged by causing an electric current to traverse it, when the red lead is reduced to the state of peroxide on the positive electrode and lead upon the negative electrode. When the whole mass has been thus electrolysed the couple is ready for discharging. On being discharged again, the reduced lead is oxidised, and the peroxide is reduced until the couple becomes inert. It is then ready for a new charge of electricity.

It is stated that a quantity of energy can be stored capable of performing a horse-power of external work during an hour in a Faure battery of 75 kilograms in weight.

A correspondent of the *Times*, "F.L.R.S." has since given an account of a meeting of the Société d'Encouragement pour l'Industrie in Paris, presided over by Mons. J. B. Dumas, at which Mons. Faure's battery was exhibited, and the following somewhat enthusiastic description of a box containing four batteries, which was taken by the writer from Paris to Glasgow:—

On Monday, 9th inst., in Paris, a Faure battery, or *pile secondaire*, was charged with the electric fluid direct from the ordinary Grove battery, and in my presence. In may be more economically done from a Gramme or Siemens machine. The receptacle consisted of four Faure batteries, each about 5 in. diameter and 10 in. high, forming a cylindrical leaden vessel, and containing alternate sheets of metallic lead and minium wrapped in felt and rolled into a spiral, wetted with acidulated water, and the whole placed in a square wooden box, measuring about one cubic foot, and weighing some 75 lb. This was protected by a loose wooden cover, through which the electrodes (in lead) protruded, and were flattened down for convenience of transport. This box of "electric energy" was handed to me by M. Faure, at my request, with the object of submitting it for examination and measurement to our eminent electrician, Sir William Thomson, F.R.S., at the University of Glasgow. I had the box by me all through the journey from Paris on Tuesday night, including a five hours' delay at Calais. I arrived at Charing-cross at 11 a.m. on Wednesday, after running the gauntlet of customs and police authorities, who suspiciously looked askance, and seemed to doubt my statement that my box only held "condensed lightning," and contained no infernal machine or new explosive destined to illustrate some diabolical socialistic tragedy. From time to time on the journey I tested the force of the discharge, and found it to have well maintained its energy. From London to Glasgow required only another 10 hours, and finally, in about 72 hours from the time of charging in Paris I had the satisfaction of presenting to Sir William Thomson, M. Faure's rare offering of a "box of electricity," intact and potent, holding by measurement within that small space of one cubic foot, a power equivalent to nearly one million of foot pounds! This wonderful box is now deposited in the laboratory of the Glasgow University, under the vigilant eye of its director, and being submitted to a series of tests and measurements.

TASAR SERICICULTURE IN INDIA.

The following report from Major Coussmaker has been forwarded by the Secretary of State for India for publication in the *Journal* of the Society:—

Camp Rajur, Ta'luka Akola, 6th March, 1881.

Sir,—I have the honour of acknowledging your letter (No. 659) of the 23rd ultimo, with its accompaniments, and beg herewith to submit, for the information of Government, my report upon the progress made by me in tasar sericulture during the last year.

2. I must first state that, though I have not succeeded in gathering a crop of cocoons of my own rearing, I have yet gained so much more experience of the knowledge of the difficulties in the way that I believe I shall eventually be able to overcome them without increasing the expense of the cultivation.

3. My failures last monsoon were owing to the imperfect construction of the cages in which I tried to rear the worms. These were at first entirely made of tarred screens of split bamboo, and served the purpose of keeping out rats, mice, birds, squirrels, and lizards, but being dark, the plants did not thrive well, and the worms were always striving to escape. I then altered the construction, made them longer and put netting at the top instead of pieces of screen, and here everything throve well for a time, until some wasps and other insects managed to get in and puncture the silkworms, from the effects of which the majority died, and very few lived to spin their cocoons. I shall try to counteract this next monsoon with coarse open cotton cloth, which will, I expect, turn out to be cheaper than netting.

4. The small plantation which I have laid out is thriving, and will, eventually, be able to support a considerable number of worms, but I have had to alter the plan to a certain extent. I adhere to my original intention of keeping the plants well pruned, and of not letting them grow more than three or four feet high, but in order to make the junctions of the screens more secure and vermin proof, I must have the ridges or banks seven feet wide instead of four. I have also removed to other ground all the other plants except the "Lagerstramia Indica" (*Gul Mendhi* or *Daiyeti*) and the "Zizyphus Jujuba" (*Bher* or *Bhori*), as these are the two kinds which thrive best with me, and I have now five hundred feet of the former and three hundred of the latter available for feeding purposes, besides several cuttings and seedlings which are coming on.

5. My collection of cleaned, perforated cocoons ready for the manufacture, now amounts to about 30,000, weighing about 60 lbs., and sown up in bags, in which state they will remain without deterioration for an indefinite period. Of this amount the Forest Department, working under Mr. Shuttleworth's instructions, contributed this season about 17,000, while the remainder consist of those which I have collected from other sources, or carried forward from last season. I propose to wait till I have got 1 cwt. before I take any steps towards disposing of this material, as no manufacturer would care to purchase a small amount.

6. One of the most promising facts in connection with tasar sericulture is the effort which is being made by Mr. George Baird with the encouragement of the Máhárája to establish a plantation at Oodeypur. Two

of the most advanced students in Mr. Baird's school came to Poona by the direction of the Máhárája, and attended my house daily for some weeks, watching the habits of the insects, and taking copious notes, which will, I hope, bear fruit some day.

7. I kept up my usual correspondence with individuals interested in the scheme, and distributed eggs to them at Oodeypur, Khândesh, Coorg, Rangoon, Ceylon, and Bombay.

8. Owing to changes among the members of the Forest Department, I have not yet been able to get all my accounts settled, but as far as I can tell, I shall have expended about Rs. 220 of the 500 placed at my disposal by Government last year, of which about Rs. 45 will have been paid to villagers for cocoons, Rs. 10 on postage, and the remainder on laying out and maintaining the plantation, in tending the silkworms, and in preparing cocoons for storage.—I have the honour to be, &c., G. COUSSMAKER, Major.

BRITISH ASSOCIATION.

The following arrangements have been made for the fifty-first meeting of the British Association, to be held at York:—The first general meeting will be held on Wednesday, August 31, at 8 p.m. precisely, when A. C. Ramsay, F.R.S., V.P.G.S., will resign the chair, and Sir John Lubbock, Bart., M.P., F.R.S., President-Elect, will assume the presidency, and deliver an address. On Thursday evening, September 1, at 8 p.m., a *soirée;* on Friday evening, September 2, at 8.30 p.m., a discourse by Professor T. H. Huxley, LL.D., Sec.R.S.; on Monday evening, September 5, at 8.30 p.m., a discourse by W. Spottiswoode, D.C.L., LL.D., President of the Royal Society; on Tuesday evening, September 6, at 8 p.m., a *soirée;* on Wednesday, September 7, the concluding general meeting will be held at 2.30 p.m. No report, paper, or abstract can be inserted in the Report of the Association, unless it is given in before the conclusion of the meeting. Excursions to places of interest in the neighbourhood of York will be made on the afternoon of Saturday, September 3, and on Thursday, September 8.

The general officers are—General Secretaries: Capt. Douglas Galton, C.B., D.C.L., F.R.S.; Philip Lutley Sclater, Ph.D., F.R.S. Acting Secretary: George Griffith, M.A., F.C.S., Harrow; General Treasurer: Prof. A. W. Williamson, F.R.S. Local Secretaries: Rev. Thomas Adams, M.A.; Tempest Anderson, M.D., B.Sc., York. Local Treasurer: W. W. Wilberforce, York.

The sections are arranged as follows:—

A. *Mathematical and Physical Science.*—President: Prof. Sir William Thomson, F.R.S. Secretaries: Prof. W. E. Ayrton; Oliver J. Lodge, D.Sc.; and Donald McAlister, B.A., B.Sc. (Recorder).

B. *Chemical Science.* — President: Prof. A. W. Williamson, For. Sec. R.S., V.P.C.S. Secretaries: Harold B. Dixon, M.A., and P. Phillips-Bedson, D.Sc. (Recorder).

C. *Geology.*—President: Andrew Crombie Ramsay, LL.D., F.R.S. Secretaries: W. Topley, F.G.S. (Recorder) and W. Whitaker, F.G.S.

D. *Biology.*—President: Richard Owen, C.B., F.R.S. Secretaries: G. W. Bloxam, M.A., F.L.S.; W. L. Distant; W. A. Forbes, F.Z.S.; Professor M'Nab, M.D.; John Priestley; and Howard Saunders, F.L.S., F.Z.S. *Department of Zoology and Botany.*—Richard Owen, C.B., F.R.S. (President), will preside. Secretaries: Professor M'Nab, M.D. (Recorder), and Howard Saunders, F.L.S., F.Z.S. *Department of Anthropology.*—Professor W. H. Flower, F.R.S. (Vice-President), will preside. Secretaries: G. W. Bloxam, M.A., F.L.S. (Recorder), and W. L. Distant. *Department of Anatomy and Physiology.*—Professor J. S. Burdon Sanderson, F.R.S. (Vice-President), will preside. Secretaries: John Priestley (Recorder), and W. A. Forbes, F.Z.S.

E. *Geography.* — President: Sir J. D. Hooker, K.C.S.I., C.B., F.R.S. Secretaries: H. W. Bates, Assist.-Sec. R.G.S., F.L.S., and E. C. Rye, Librarian R.G.S., F.Z.S. (Recorder).

F. *Economic Science and Statistics.*—President: The Right Hon. M. E. Grant Duff, M.P., F.R.S. Secretaries: Constantine Molloy (Recorder), and J. F. Moss.

G. *Mechanical Science.*—President: Sir W. G. Armstrong, C.B., F.R.S. Secretaries: A. T. Atchison, M.A. (Recorder), and H. Trueman Wood, B.A.

Tickets for the meeting may be obtained of the Local Secretaries at York, and at the office of the Association, 22, Albemarle-street, London, W.; or on application by letter, from August 17 to August 24, to the General Treasurer, Professor A. W. Williamson, British Association, University College, London, W.C.

QUEBRACHO WOOD.

Mons. F. Rhem has lately communicated a paper on the "Quebracho Wood" to the *Société Industrielle du Rouen*, from which the following particulars are extracted:—This wood belongs to the family of the Asclépiades, and comes from America. Being very hard, and composed of a great quantity of interlaced fibres, the tannin it contains is different from that of chestnut or of oak. Gelatine precipitates this tannin out of a water solution with a flesh colour, while salts of protoxide of iron give an ash-grey precipitate, and the peroxyde salts a dirty greenish colouration. When boiled with weak sulphuric acid, the tannin is not converted into gallic acid. According to a German chemist, quebracho wood contains 18 per cent. of tannic acid. The back of this wood contains an alkaloid analogous to quinine. Extract of quebracho, now much used in wool dyeing, giving a yellow shade with a tin solution. It gives even shades, resembling those of cutch, if used with bichromate of potash, but its principal use is for obtaining blacks, for which the wool is given first a bottom of the extract, then passed through iron, and dyed with the quebracho; this, in these conditions, can replace cutch. Solutions of quebracho wood, or extract, will only keep limpid if heated to a certain temperature, but get turbid on cooling. Dyeing experiments, with the dry quebracho extract, as manufactured by a French firm, in comparison with cutch, have proved the former of more value, since, with a lower price, it possesses a greater richness of colouring matter. Three series of trials were made: one, by passing the cotton prepared in a quebracho or cachou bath through bichromate of potash; the second, through iron; and, in the third, the patterns were passed through iron and then chromed. In all cases the same results were obtained, showing the advantage of the quebracho over cutch, in spite of a slightly more greyish shade of the colours obtained with the former. The same results have been got by printing mordants on calico, ageing, dunging, and dyeing with quebracho extract or cutch; in all cases the quebracho shades being identical with those of cutch, not only for the tone of colour, but also in regard to fastness.

GENERAL NOTES.

Ladies' Sanitary Association.—At the meeting of this association, held last week, on the occasion of the distribution of prizes by H.R.H. Princess Christian, of Schleswig-Holstein (see *Journal*, p. 552), Sir Henry Cole, in replying to a vote of thanks passed to the Society of Arts for the use of the hall, said it was the business of that Society to do what other people—Government especially—did not do, and to show the Government a better way of doing things. At

present the Society was engaged in a most interesting work. Ladies were doubtless aware that in this country the system of teaching needlework was confined to senior wranglers. Now this Society was trying to induce ladies to conduct a course of instruction in domestic economy, including the teaching of needlework, the making of clothing, cooking, and other arts in which woman shone pre-eminent, but the teaching of which, by accident, had got into the hands of men.

Suez Canal.—In the course of 1880, 2,017 ships passed through the canal with a tonnage, according to official reckoning, of 2,860,448, but really amounting to 4,378,964. The number of hands employed in the navigation was 128,453; the number of passengers, 53,517. Of the 2,860,448 tons official reckoning, 2,247,306 were British, 177,771 French, 75,820 Austrian, 124,083 Dutch, 71,039 Italian, 56,245 Spanish, 38,162 German, 29,607 Russian, 7,203 Turkish, and 8,032 Egyptian, while 25,180 tons belonged to other States.

Total Production of Coffee.—According to the Batavian *Journal of Agriculture*, the production of coffee by the whole world, in 1855, was 330,152 tons, and, in 1878, no less than 490,843 tons, showing an increase during the 23 years of 160,675 tons. These quantities were yielded by the following countries:—

	1855.		1878.	
Brazil	163,400	tons.	225,500	tons.
Dutch Indies	71,322	,,	91,405	,,
West Indies	29,300	,,	41,800	,,
British India and Ceylon	28,780	,,	53,422	,,
South Africa	22,315	,,	35,890	,,
Arabia	6,176	,,	2,779	,,
Africa	4,000	,,	4,000	,,
Central America	3,500	,,	32,500	,,
Philippine Islands	1,359	,,	3,397	,,
Oceania	—	,,	150	,,
	330,152		490,843	

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at eight o'clock:—

May 25.—Adjourned Discussion on Mr. Alexander Siemens's paper on "The Electrical Railway, and the Transmission of Power by Electricity."

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

May 31.—"The Principality of Loo Choo." By Consul John A. Gubbins.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Fifth Course will be on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

Lecture II.—Monday, May 23.

Mistakes of the colour-blind in daily life. Their methods of endeavouring to counteract the consequences of their defect. Modes of testing for colour blindness. Sources of error in testing. The actual prevalence of the affection in this and other countries, and in different classes of the population.

Lecture III.—Monday, May 30.

Industries chiefly affected by colour blindness—Engine-drivers, pilots, artists, letter-sorters, drapers, painters, &c., &c. Recent legislation affecting colour blindness in America, and urgent need for it in this country. Conclusion.

MR. SHELFORD BIDWELL'S PAPER.

In consequence of Mr. Bidwell's severe indisposition, he has been unable to prepare his paper on "Telegraphic Photography," announced to be read before the Applied Chemistry and Physic Section on Thursday, May 26th, and the reading has, therefore, been unavoidable postponed.

INDIAN SECTION.

Sir Arthur Phayre's paper on "Burmah," and the discussion, will be printed in next week's *Journal*.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 23rd...**SOCIETY OF ARTS,** John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. R. Brudenell Carter, "Colour Blindness, and its Influence upon Various Industries." (Lecture II.)
National Indian Association, 11, Chandos-street, W., 8½ p.m. Mr. C. N. Banerjee, "Home Education for Indian Ladies."
Royal Geographical, University of London, Burlington-gardens, W., 2 p.m. Annual Meeting.
British Architects, 9, Conduit-street, W., 8 p.m. 1. Distribution of Medals and Prizes. 2. Prof. Donaldson, "Some Observations on the Mariette Excavations at Sakkara, in reference to Discoveries recently made there."
Geologists' Association, University College, W.C. Excursion to Sheppey.

Tuesday, May 24th...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Non-Metallic Elements." (Lecture V.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on Mr. John I. Thornycroft's Paper, "Torpedo Boats and Light Yachts for High-Speed Steam Navigation." 2. Mr. Richard Henry Brunton, "The Production of Paraffin and Paraffin Oil."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. Dr. Allen Thomson, "Some Bone Necklaces from the Andaman Islands. 2. Mr. E. H. Man, "The Arts of the Andamanese and Nicobarese." 3. Mr. M. J. Walhouse, "Some Vestiges of Girl Sacrifices, Jar Burial, and Contracted Interments in India and the East."
Royal Horticultural, South Kensington, S.W., 1 p.m.

Wednesday, May 25th...**SOCIETY OF ARTS,** John-street, Adelphi, W.C., 8 p.m. Adjourned Discussion on Mr. Alexander Siemens's paper, "The Electrical Railway, and the Transmission of Power by Electricity."
Geological, Burlington-house, W., 8 p.m. 1. Dr. Henry Hicks, with an appendix by Mr. R. Etheridge, "The Discovery of some Remains of Plants at the base of the Denbighshire Grits, near Corwen, North Wales." 2. Mr. Edgar Willett, "Notes on a Mammalian Jaw from the Purbeck Beds at Swanage, Dorset." 3. Prof. H. G. Seeley, "The Reptile Fauna of the Gosau Formation."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. C. Pfoundes, "The Popular Literature of Old Japan."
Telegraph Engineers and Electricians, 4, The Sanctuary, Westminster, S.W., 8 p.m. Mr. P. V. Luke, "The Construction and Working of a Military Field Telegraph, based upon Experience gained during the Campaigns in Afghanistan in 1878-79-80."
National Education Union, Westminster Palace Hotel, S.W., 2½ p.m. Annual Meeting.
Ascham Society, 18, Baker-street, W.
Royal Botanic, Inner-circle, Regent's-park, N.W., 2 p.m. Summer Exhibition.

Thursday, May 26th...Linnean, Burlington-house, W., 3 p.m. Anniversary Meeting and President's Address.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Paramagnetism and Diamagnetism." (Lecture V.)
Inventors' Institute, 4, St. Martin's-place, W.C., 4 p.m. Annual Meeting.

Friday, May. 27th....Royal United Service Institute, Whitehall-yard, 3 p.m. Major-General D. J. Newall, "Military Colonisation as a Reserve for India."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. H. E. Roscoe, "Artificial Production of Indigo."
Quekett Microsc pical Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.
National Health Society, 23, Hertford-street, W., 4 p m. (Drawing-room Lectures.) Mr. Ernest Hart, "Recent Progress in Health Knowledge."

Saturday, May 28th...Physical, Science Schools, South Kensington, S.W., 3 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. E. Turner, "Russian Literature." (Lecture II.) Lermontoff.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,488. VOL. XXIX.

FRIDAY, MAY 27, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CONVERSAZIONE.

The Society's *Conversazione* is fixed to take place at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Thursday, the 2nd June.

A Promenade Concert will be given by the String Band of the Royal Engineers, in the North Court. Mr. R. Corney Grain will give Three short Entertainments in the Lecture Theatre. Madame Frickenhaus will give a Pianoforte Recital in the Picture Gallery.

The Galleries containing the Raphael Cartoons, the Sheepshanks Collection, the Wm. Smith Collection of Water Colour Drawings, the Dyce and Forster Pictures, the Collection of Paintings lent by the Trustees of the late Rev. Pryce Owen, and "The Chantrey Bequest," will be open.

The Courts and Corridors of the Ground Floors will be open.

The Reception will be held in the Architectural Court, by Mr. F. J. BRAMWELL, F.R.S., Chairman, and other Members of the Council.

The cards of invitation have been issued to members.

CANTOR LECTURES.

The second lecture of the fifth Course, on "Colour Blindness and its Influence upon Various Industries," was delivered by R. BRUDENELL CARTER, F.R.C.S., on Monday, 23rd inst. The lecturer related some of the mistakes of the colour-blind in daily life, and their methods of endeavouring to counteract the consequences of their defect. He described the modes of testing for colour blindness, and the sources of error in certain modes which have been adopted. Prof. Holmgren's test, by means of skeins of coloured worsted, was explained and illustrated, and the lecture concluded with statistics of the actual prevalence of colour blindness in this and other countries, and in different classes of the population.

The lectures will be printed in the *Journal* during the autumn recess.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, was opened on Saturday, 21st inst. A non-tranferable season ticket will be sent to any member of the Society on application to the Secretary.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Dr. Hullah, the Society's Examiner, at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 4th July, 1881.

HONOURS.

The Examination in Honours will consist of three sections, viz., a paper to be worked, an examination similar in form to the practical examination for a First and Second-class, and a *viva-voce* examination.

FIRST AND SECOND-CLASS.

Vocal.

Candidates for a First or Second-class Certificate in Vocal Music will be required—

[1.] To sing a solo, or to take part with another candidate in a duet, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, or successions of sounds or intervals, played or sung by the Examiner.

[3.] To sing or sol-fa at sight passages selected generally from classical music.

Instrumental.

Candidates for a First or Second-class Certificate in Instrumental Music will be required—

[1.] To play a short piece, or a portion of a larger work, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, played by the Examiner.

[3.] To play a piece or portion of a piece at sight.

The examination of each candidate will be private; no one but the Examiner and the accompanyist being present, unless it be a member of the Society of Arts' Committee.

No list of Candidates will be published.

Full particulars can be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

Friday, May 13th, 1881; Sir RUTHERFORD ALCOCK, K.C.B., in the chair.

The paper read was—

BRITISH BURMA.

By General Sir Arthur Phayre, G.C.M.G., K.C.S.I., C.B.

The province of British Burma, by the rapid progress that it has made in material prosperity during the last twenty years, has attracted the attention of all who are interested in the empire of India. In submitting to this Society a brief account of the present condition of that country, it is necessary to state that statistics of trade and revenue are not available for a later period than 1879-80, but the population by the census of this year has just been received, and that for the purpose of illustration of the comparative progress of the province, it is not proposed to do more than briefly refer to some of the statistics for a few years preceding that above mentioned.

It is scarcely necessary to remind you that the country called Burma, that which is inhabited mainly by people of the Burmese race, and which is as distinctively the country of the Irawadi and its tributaries as Egypt is the gift of the Nile, is divided politically into two parts: British Burma, and Independent Burma. It is proposed on the present occasion to deal principally with the former, and to refer only incidentally to the latter.

British Burma was formed, to speak generally, from the union of three maritime provinces, two of which, Arakan and Tenasserim, were annexed to the British Indian Empire in 1826, and one, Pegu, which became British territory in 1852. The province has a direct sea coast line extending about nine hundred miles along the eastern shore of the bay of Bengal. Though for such an extent the number of ports is limited, yet the outlets of the great rivers give at Akyab, Bassein, Rangoon, and Moulmein, admirable positions for trade with other countries. The province has an area of about 94,000 square miles, being a little larger than Great Britain.

The Burmese people who, including the Talaings or Peguans, form about five-sixths of the population of British Burma, are classed by ethnologists as Mongoloids. The numerous hill tribes, Karens, Khyengs, Kamis, and others, belong to the same family. The Burmese, by their physiognomy as well as by their language, show that they belong to the same family as the Bhote, or people of Tibet. The connection from the one to the other, though their countries are so far apart, may be traced by similarity in the physical form, and speech of tribes dwelling on the south-eastern border of the great plateau of Tibet, and bordering the way along the courses of rivers to the country of the middle Irawadi. The Burmese language may be roughly described as monosyllabic, though this classification can only be applied to it with considerable modification. The Talaing people, who chiefly inhabit the delta of the Irawadi, may, no doubt, be traced to the same original seat as the Burmese; but their ancestors appear to have left it at a much earlier period than the forefathers of the latter. Their language, which now differs materially from that of the Burmese, has become nearly extinct, and there is, perhaps, a larger Talaing-speaking people in Siam than in Pegu. The total population of British Burma, by the census of this year, amounts to 3,704,253 souls. In order to show the great increase in population which has taken place, it may now be stated that, in 1855-6, the population amounted to 1,252,555 souls. Probably the number may then have been under-stated from defective returns; but even supposing that the deficiency reached to so much as a quarter of a million, about one-fourth of the whole, the fact will remain that, in a quarter of a century, the population has nearly trebled. This, no doubt, has resulted largely from immigration from Upper Burma, but the people are also increasing from natural causes, consequent on freedom for their industry, the absence of war, and, it is believed, generally improved sanitary condition from better food and clothing.

The amount of imperial revenue—that is not including what is collected by municipal rates—raised from this population amounted, in 1879-80, in round numbers to £2,100,000. That is a far greater proportional amount than is paid by any other province under the Government of India. It may, at the same time, be noted that the amount collected in 1855-56 was, in round numbers, £531,792. While, therefore, in twenty-five years the population has nearly trebled, the revenue has nearly quadrupled. This great increase, I feel assured, has resulted from general increase of prosperity, and not from excessive taxation. I may add that the only item on which I would wish to see a reduction in the annual revenue is on that arising from the consumption of opium. The quantity consumed might be very much reduced by Governmental action with great advantage to the community, and I learn within the last few days that measures have been adopted for that purpose.

In considering the question of progress in the prosperity of British Burma, nothing is more instructive than the continued regular advance in the area of cultivated land. By far the most important agricultural product is rice. It may almost be considered the one agricultural product of British Burma, so much does it exceed in quantity all others. This results from the soil and climate being very suitable to that cereal, and to the people thoroughly understanding the method of cultivation required. Under the native Government, rice was not allowed to be exported by sea, from the notion that so necessary an article of food should be kept in the country, as a reserve in case of famine. Consequently, not more was produced than was required for local consumption. After the country became British, and sale of produce was unrestricted, the people at once extended their cultivation. The result will be seen in the following figures. In 1855-56, the total area of cultivated land paying revenue to Government was 1,075,374 acres. In 1879-80, the area was 3,364.726 acres. The value of rice exported by sea was, in 1855-6, £1,482,475; and in 1879-80, £5,274,311.

Land in Burma is owned by small proprietors. The right of property in the soil is independent of the governing power, and is so laid down in the Buddhist scriptures. The average area of each estate on which rice is raised, is not more than seven to eight acres. That is the area available for cultivation. Grazing land is that which is left wild round each village, and is common to the landowners thereof. All owners exercise the right of sale, lease, gift, and mortgage, though sale outright is very seldom made. There appears to be an objection to it which may almost be called religious, irrespective of the rights of heirs, which cannot be alienated, and when land is sold by deed, it is generally expressed that the object of the purchaser is to build a pagoda or other religious edifice thereon. This is supposed to justify the sale. Rice land is occasionally let from year to year, on verbal engagement, the tenant agreeing to pay ten per cent. of the produce.

The development of commerce in British Burma has kept pace with the increase of population and cultivation. The export of rice has already been stated in connection with the extension of cultivation. The trade of the province may be classed as (1) that carried on by sea with foreign countries, and with British India; and (2) that carried on by river navigation, or by inland caravan traffic with Independent Burma, China, and Siam.

The great increase in the sea-borne trade will be seen from a comparison of figures for 1879-80, with those for 1871-72. For both years all imports and exports of goods on account of the Government have been excluded.

1871-72.—*Imports and Exports.*

Value of merchandise	£6,938,202
Treasure	1,311,356
Total..........	8,249,558

1879-80.—*Imports and Exports.*

Value of merchandise	£12,348,373
Treasure	3,206,939
Total..........	15,555,312

It will not be necessary to do more than mention the principal articles. The two of most importance to the United Kingdom are the cotton and silk piece goods, the cotton twist and yarn of British manufacture. The value of those goods imported in the year 1871-72, amounted to £1,385,011, and woollen goods to £88,372. In 1879-80, the value of the former amounted to £2,006,453; and woollen manufactures to £225,915. When I say these were of British manufacture, it should be noted that, strictly speaking, 97 per cent. of the goods were shipped from the United Kingdom. Considering the population of British Burma small in comparison with that of most provinces in British India, this is a very large proportional amount of annual consumption. Of the quantity of such goods which is supplied to people in the interior, in countries beyond the British frontier, I will speak when I come to notice the inland trade.

The exports from British Burma by sea consist principally of rice, the value of which has already been stated for one year. The next article in importance is teak timber, which is probably the most valuable wood known for ship-building and industrial purposes. There has been a considerable falling off in the export of teak timber within the last five years. In 1875-76, the value exported amounted to £432,389, and in 1879-80, to only £273,967.

Teak timber exported is grown both in British territory and beyond it. The teak forests in British Burma are the property of Government, and are carefully conserved. No care appears to be taken of those in Independent Burma, or in Siam, and it is to be feared that the destruction now going on must in a few years render it impossible to find large-sized timber in those countries, in such positions as to be available for the market. In the districts of British Burma, which were annexed in 1826, similar waste was allowed. It was only in 1852, when experience had shown the absolute necessity of guarding against indiscriminate felling of trees, that the Marquis of Dalhousie issued orders for the formation of a forest department in the province. First under Dr. McClelland, and afterwards under the present Inspector-General of Forests in India, Dr. Brandis, successful measures were adopted, for the conservancy of forests. This it was which led to the formation of a Forest Department for all India, which it is now acknowledged has been of vast benefit to the empire.

The growth of teak trees in British Burma is secured partly by planting in suitable localities, and by guarding against destructive agencies all young trees whether planted or of natural growth. The principal destructive agencies are:—Fire, which in the dry season, unless prevented, frequently spreads over hundreds of square miles, and kills young trees; parasitical plants; and the method of clearing ground for cultivation on mountain slopes carried on by the hill tribes, who indiscriminately fell trees and burn them in one mass. The latter enemy to forest conservancy is, perhaps, the most difficult to deal with, as there is great danger of exciting the ill will of the hill tribes by interference with what they have from time immemorial considered their right. Great caution therefore is necessary, and has been observed in carrying out measures necessary to check the destruction of trees by that means. Teak trees which have arrived at maturity, that is at the age of eighty to ninety years, are girdled two or three years before they are intended to be felled. The rise of the sap being thus intercepted, the trees die, and they become thoroughly seasoned while still standing. They are then capable of being floated down the streams and rivers without delay after having been felled. During the last five years there has been a material decrease in the yield of teak timber in the forests of British Burma. This will be seen from the following table of the actual quantity brought down during each year:—

	Tons.
1875-76	46,597
1876-77	46,431
1877-78	39,081
1878-79	22,763
1879-80	17,585

It must not be supposed that the diminution in the annual supply brought to market indicates a diminution in the actual number of mature, or full-sized teak trees existing in the forests. The reduction proceeds from various causes, and it may

be confidently pronounced that the effect of the forest conservancy in British Burma has been to render available for public use a valuable natural product, while guarding against wasteful felling, which would, in a course of years, extinguish the supply for future generations. Various other timber trees are cared for in the forests of Burma, which is not necessary to enumerate. Cinchona trees have been planted, but the result, as yet, has not been favourable.

As regards the teak timber floated down the rivers into British Burma from the neighbouring countries, it will suffice to observe that the quantity is about four times that derived from forests in British territory. But, as already stated, as no conservancy is exercised in those countries, the supply, before many years, will probably be much reduced. Other articles exported from Burma are cutch cotton and petroleum, but they do not call for any particular remark. One abundant natural vegetable substance, however, promises to become utilised, and to add to the products exported to other countries. I allude to the manufacture of paper from bamboo fibre, which has been undertaken by Mr. Thomas Routledge. This enterprise will turn to good account a plant which grows rapidly in every part of British Burma; and there are many tracts where plantations of it may be formed for the object in view. The material would be exported in the shape of fibrous paper stock.

The inland trade of British Burma with Independent Burma and the Shan States is only yet in its infancy; but it has made great strides within the last few years. The progress during eleven years has been gradual, and is shown by the following figures:—

1869-70.	
Value of exports	£1,283,588
Value of imports	905,308
Total	2,188,896
1879-80.	
Value of exports	£1,880,052
Value of imports	1,983,354
Total	3,863,406

In order to show the value of the inland trade of British Burma in articles of British manufacture, and its progressive increase in eleven years, the following statement of the value of exports of textile and fibrous fabrics is given:—

	1869-70	1879-80
Cotton piece goods	£44,549	£191,821
Silk piece goods	9,025	168,936
Woollen piece goods	7,941	43,524
Cotton twist and yarn	49,281	157,924
Total	110,796	562,205

The great bulk of the trade with Independent Burma is carried on by the River Irawadi. It is worthy of notice that, notwithstanding the unsatisfactory state of the relations of the British Government with the Court of Mandalay, trade between the two countries has not materially suffered. The great object of establishing and maintaining a direct trade with Yunnan has not been accomplished. The main obstacle to success may be attributed to the Chinese merchants settled in Burma, and to the Chinese local authorities on the border. The opposition of the former arises from jealousy of foreigners, and what every other people similarly circumstanced shows, dread of losing a profitable trade. On the whole the Burmese Government has been faithful to its treaty engagements with the Governor-General of India, and with prudence and avoidance of aggressive conduct, which is certainly not likely to arise from the Burmese Government, there is no reason for doubting that the interests of both countries, as regards friendship and commerce, will be maintained.

Means for ready locomotion and conveyance of produce are, of course, directly connected with trade and all material progress. When the province was first occupied by the British Government, there was an entire absence of means for internal communication, except by the rivers. In Arkan and Tenasserim the great annual rainfall constituted a serious obstacle to the construction and maintenance of roads, the outlay necessary to resist the abrading force being great, and the prospect of return or benefit in a sparsely-populated country, remote. In Pegu, the Irawadi has always been a great highway, and in the delta which extends over ten thousand square miles, hundreds of intersecting navigable creeks form an excellent medium for movement by vessels of all sizes, from the tiny canoe to barges of a hundred or more tons burden. But made roads for wheeled vehicles were unknown. Main lines of metalled road have, under the British Government, been constructed, but only to a small extent. The total length of these does not exceed five hundred miles. The building of village and distinct roads to connect with main lines will yet occupy many years. A railway has been built from Rangoon to Prome, a distance of 163 miles. The success of the line after four years has been greater than could have been anticipated, considering the bulky nature of the products to be carried, and the nearness of the river to the line. The net earnings by the last account were 4 per cent. on the outlay. The chief source of profit appears to be by passenger traffic.

The navigation of the Irawadi by the steamers of the Irawadi Flotilla Company continues uninterrupted, notwithstanding occasional reports of unfriendly relations with Independent Burma. In 1879-80 there were made 129 trips up, and 121 down, between Rangoon and Mandalay. No trip to Bamau appears to have been made. A canal to connect the Pegu river with the Sittang river completes the water highway between Rangoon and Toungoo, and is a great advantage to trade. A railway between the same towns has also been sanctioned by Government, and will be commenced at once. The coast of British Burma, and the several ports are well-provided with lighthouses. There are seven, and one light vessel.

Among remunerative public works, the embankment of the Irawadi takes a prominent place. An exhaustive report thereon has been made by Mr. Robert Gordon, C.E., under whose direction the works now are. The object of the embankment was to protect cultivated and cultivable land from inundation. This has to a considerable extent been effected. But as is to be expected in dealing with a great river, having a rise of about forty feet when in flood, and an extreme discharge in the rainy season, thirty miles above the head of the delta, of two millions of cubic feet per second,

many complications have arisen, and the question of further embankment is still under consideration. In the lower part of the delta there are some thousands of square miles which can be made culturable by an embankment, and where the difficulty from the destructive force of current is much reduced. Mr. Gordon has, with reference to the periodical rise of the Irawadi, the rainfall in the eastern Himalaya, and the discharge of water by the rivers entering the Brahmapootra from the north, in Assam below Sadiza, concluded that the Irawadi is the continuation of the Sanpo of Thibet. This is one of the few great questions in the geography of Asia which has still to be solved, and which has been a subject of controversy since the time of d'Anville.

A paper proposing to treat of British Burma, however cursorily, would be incomplete without some notice of the state of education. Elementary knowledge of reading and writing is more generally diffused among the people of Burma than is the case in India, and even in some countries of Europe. This has resulted from the fundamental principles of Buddhism. For the Buddhists having originally protested against Brahman exclusiveness in matters of religion, and as regards the acquisition of knowledge by those outside their own body; and having contended for the right of all to rise by personal merit to ecclesiastical and secular eminence, and to inherit a higher reward by transmigration, the doctrine led to a general diffusion of instruction among the masses of the people. Hence in Burma all male children are taught letters; the national schools are the Buddhist monasteries, and the schoolmasters or the directors of the studies are the rahâns or monks. There are also in some towns lay schools, in which both boys and girls are taught. The rules of Buddhist monks prevent them from teaching girls; but female education is, among the higher classes, carried on in families, as well as in lay schools. The great importance of attention being directed to the indigenous schools of British Burma will be seen from the number of scholars in the monasteries and lay schools, the heads of which have agreed to receive Government inspection. The number is 70,858 boys, and 3,330 girls.

In these indigenous schools the medium of instruction of course is the vernacular language of the country. In the majority of instances the instruction does not extend beyond mere reading, writing, and arithmetic. In the monasteries there is generally very little of the latter, as it is not regarded as a part of religious knowledge, and is, therefore, a hindrance rather than a help to the progress of those who enter the path. The rahâns have, however, had the good sense to allow this branch of secular knowledge to be taught in their monasteries. In the monasteries those boys who it is intended by their parents should become monks remain for years, while the great majority leave early. The object of the Government in connection with the monastic schools has been to avoid all interference with the religious teaching, and to induce the head monk of each monastery to admit inspectors, in order that the secular studies should be more systematically pursued, and the course be more advanced than hitherto. For this purpose elementary books on arithmetic, geography, and other subjects have been supplied, and are used. The monastic schools are far more numerous than the lay, there being in 1879-80, 2,693 of the former to 355 of the latter. But more difficulty has been formed in bringing the former into connection with the Government, and it is only in the latest report that it is stated—

"The monastic schools have made a remarkable advance, especially in the most important districts. Annual examinations of the monastic and lay schools are held, and prizes awarded. The girls in the lay schools are distinguished for their zeal and aptitude."

The Chief-Commissioner, in his resolution on the results of the year, observes:—

"After some years of only partial success, the Education Department has, mainly through the instrumentality of Burmese inspectors, got the teachers of monastic schools to accept with gladness, which now seems to be heartfelt, the visits, the inspection, and the guidance of our educational officers."

When it is remembered that the object in view necessitated action by Europeans, through native agency, in the denominational schools of an Asiatic people, and made it imperative to convince the heads of those schools of the entire absence of any wish or intention to interfere with, or counteract the religious instruction going on under the same roof to the same pupils, it will be felt that success could only have been attained by a rare union of tact, discretion, and earnest perseverance on the part of those to whom the work was entrusted. For the result, the Education Department of British Burma, under the direction of Mr. Hordern, may well be proud.

Of other educational work, it will only be necessary briefly to observe that numerous schools have been established in British Burma by American, French, and English missionaries. The American Baptist missionaries were the earliest in the field, and have achieved great results among the Karen people. The missionary societies have primary vernacular schools, and also secondary schools, in which the English language is taught. All these receive aid from Government, on account of the secular instruction given. The Government have also second-class schools in each district, while in Rangoon there is a High school, which has lately been affiliated to the Calcutta University. Each year pupils pass the University entrance examination, and some are now reading for the First Arts examination. Considering that the most populous part of Burma, which furnishes the great majoirity of students, has been a British possession for less than thirty years, it may be pronounced that the advance made in sound education has been satisfactory, and is evidence of the capacity of the people, and their desire for improvement.

I have endeavoured, in the time allotted to me, to place before you the several points in the present condition of a people differing in race, in language, and in religion, from the people of India; and I trust that the result will appear favourable to their moral and material progress. It is evident that the country and the people have before them a great future.

DISCUSSION.

Sir Henry Norman, K.C.B., said he had twice visited British Burma, and on each occasion had experienced the

greatest possible interest in doing so. The first occasion was more than 20 years ago. To speak of Burma, was to speak of Sir Arthur Phayre, for the two seemed to be inseparably connected. Sir Arthur Phayre was almost the first British representative in Burma. He started the province, and after many years of good government, left it in a fair way of that progress which had hitherto continued. Certainly, no province in India that he knew of had made such wonderful progress in the last 25 years, and it seemed as if that progress would still go on at the same rate. How much of that was due to Sir Arthur Phayre some of those present knew. It would be very interesting if some of the gentlemen who had spent many years in Burma, whom he saw present, would add to the information which had been given. Up to a recent date almost the only mode of travelling in Burma was by water, and that was accomplished with great comfort, and he hoped with profit to the steamboat company; but, within the last few years, railways had been started. At first there was a good deal of opposition to the project, and fears as to its result, but these doubts seem to have been quite dispelled by the experience already gained. He hoped the railway systems now projected in British Burma would be carried out, and he was quite sure they would be not only profitable to the State, but would conduce to the prosperity and progress of the country.

Mr. E. G. Man desired to thank Sir Arthur Phayre for his excellent paper, which was really exhaustive. He, as an old Anglo-Burman, recognised several gentlemen who had passed many years in the country, but if he might speak for them as well as himself, he should say that every subject had been touched upon in so masterly a manner by one who knew Burma so much better than most of them, that it would be superfluous to add anything. He would only make one remark on one part of the paper, and that was with regard to the statement that there was no communication at present, or were none last year, between Mandalay and Bhamoo. He believed steamers had been running between those places up to the present time. He had also something to do with the timber business there, and could endorse every statement made with regard to the destruction which had taken place amongst the teak forests. Every year the size of teak timber was so decreasing that they had to go farther and farther inland for it; and even in the independent province of Upper Burma, the teak forests had been so worked out that, at the present moment, there was very little about, and in a few years there would not be a tree of any fair size to be got at. Of course, water carriage was of great importance in this respect, to enable them to get the timber down Rangoon, so that the merchants could sell it with any chance of realising a profit. With regard to the question of education, also, he could fully endorse Sir Arthur Phayre's statement respecting the experiments made by Mr. Horden and the Educational Department. There was no doubt that Burma was one of the best educated countries in the East. The people seemed anxious to learn; the monks taught them uncommonly well. He had not the slightest doubt there was a great future before British Burma.

Mr. Wm. Botly desired to make a remark or two on the influence of forestry on the climate and agricultural interests of the country. Only that day he was reading, in the Royal Agricultural Society's *Journal*, just published, a statement that the idea of an international exchange of reports on corn and forestry was first started in 1872, when, in Pesth, resolutions were passed in favour of agricultural meteorology receiving attention. That was brought before the Meteorological Congress at Rome, in 1879; and a Congress was held in September last year in Vienna, which was attended by 22 members, representing meteorology and agriculture of Europe in about equal proportions. Austria sent 8 representatives, France 3, Germany 5, Hungary 2, Belgium, Denmark, Italy, and Switzerland 1 each. Russia and Great Britain were not represented, unfortunately; but in our own case, the Meteorological Society had taken the programme of subjects to be discussed into careful consideration, and had drawn up and forwarded a series of replies to the various questions therein contained. For further information as to the result of the Conference, he must refer gentlemen to the *Journal of the Royal Agricultural Society*, as it was too long to repeat. It showed the great interest taken throughout Europe in this question, and there could be no doubt that it was of equal importance in India and Burma. He was glad that it had received attention in the paper, and hoped the Government would do all it possibly could to preserve the forests.

Mr. Pfoundes asked if Sir Arthur Phayre thought Burma would be a likely field for research with regard to ancient literature. Perhaps, at some future time, he might give them further information about the indigenous literature of the country. Something had been said about education, but he did not notice anything with regard to old literature. He should like to know whether it was much affected by the ancient Chinese, or by the more modern Chinese under the Buddhist; or if there were any traces of old Arabic literature. He believed also there was a wide field in Burma for anthropological investigation.

Mr. Thomas Routledge said he was very glad to have an opportunity of adding a few remarks to the very interesting and instructive paper, especially as being greatly desirous of utilising some of the present waste products of Burma. For nearly thirty years he had devoted his attention to the utilisation of raw fibres for paper-making, and during the last six or seven years had devoted himself especially to the bamboo omnipresent in Burma as a valuable paper-making material. There were numerous other fibrous plants indigenous to that country, which might be cultivated with advantage, but the bamboo received his special attention, because it grew in almost inexhaustible abundance, in many districts occupying many hundreds of square miles, to the exclusion of all other vegetation, and the facility of its treatment was unexampled. All the other fibres, such as the aloe, the penguin, the plantain (*musa textilis*), &c., required a large amount of manipulation, and, hitherto, no suitable machinery had been devised for the purpose. This created a difficulty in utilising them, because the country being sparsely populated, the labour requisite for treating these fibres, which were chiefly suitable for textiles, could not be obtained. A paper-maker was compelled, from the exigencies of his trade, to be content with the refuse of these fibres, and he feared that the expense of producing them as textiles would, for some years to come, be prohibitive. The bamboo, on the contrary, threw up long shoots every year, almost perennially—for 60 or 70 years at least when once established. All you had to do was to cut them down, pass them into one of those streams with which the country abounded, float them down to the port, crush them, and convert them into rough "stock" (a sample of which he produced), and there was the material that paper-makers were so much in want of. These bamboos cost nothing but the collection, and though the population was sparse, he believed the difficulty could be got over. Of course the population could not live in the impenetrable jungle, but as it became cleared, the population would follow, provided there were occupation for them. In a small pamphlet, published some time ago, he drew a parallel between the bamboo and asparagus, the main difference being that you could only cut asparagus for five or six weeks, while the bamboo season lasted several months. He believed it would ultimately form a good textile material. The Burmese made rope of it; the houses they lived in, the masts

and spars of their vessels, and nearly everything else was formed of bamboo. An important Blue-book had lately been issued by the Government of India, written by Mr. Liotard, of the Agricultural Department, giving a history of the materials suitable for paper-making in India. As he had said, Burma was exceedingly rich in other fibres, as hemp, flax, jute, and the hibiscus tribe; but all these, like the aloe, required to be cultivated, to be cut and dried, then steeped, or retted, and then hand manipulation was needful to prepare them for the market; whereas the bamboo required nothing at all. The process the bamboo underwent was simply to crush the raw stem and boil it, and reduce it to a tow-like condition, when it could be compressed like jute or cotton, and it would then come into the ordinary freightage of those articles—about 45 cubic feet to the ton. This was done by a process he had patented in India. The bamboo, when dried and in its natural condition was very hard and intractable, and, with any system of simple crushing, could not be brought into a suitable bulk for freightage, which, after all, was a most important point, as affecting the cost of any raw material. A ton of produce, whatever it might be, should not occupy more than about 40 cubic feet as dead weight, but the bamboo, crushed to the utmost possible extent, would occupy 96 cubic feet, and if merely crushed in the ordinary way, even under a pressure of two or three tons to the square inch, would occupy 125 cubic feet, and, therefore, it could not come to this country as a raw material without some previous treatment. Treated as he proposed, its cost here would be about the same as the very cheapest material in the market. He was glad to say that he had received the very warmest support from the Indian Government, and he was pleased to have this public opportunity of expressing his acknowledgements to the Chief Commissioner Mr. Bernard, Dr. Brandis the Inspector-General of Forests, and Mr. Ribbentrop and Major Seaton, the Forest Conservators, with whom he had been in communication. There were at first some cavillers, but on the whole they were now coming round to his views. He had now a special concession from the Indian Government in Burma, having chosen that province on account of its very favourable climatic conditions, particularly the large amount of rainfall on the coast, which was as much as 160 to 200 inches per annum. In some parts there, rain or showers fell nine months out of the twelve, which was very favourable to the rapid growth of the bamboo. Towards the north there was not so much rain. The soil was a rich loam, and in Arrakan there was an abundance of streams, which enabled you to float the stuff down to the port. (He produced samples of crushed bamboo, "paper stock," "half-stuff," and also paper made entirely of bamboo.) Sir Arthur Phayre had referred to the enormous increase in the shipments of rice from Burma, and he might mention that the first shipment of 3,000 tons was made by his friend Mr. Begbie, in 1855. In 1856, the shipments were 50,000 tons; and by 1860, 80,000 tons; while, last year, they exceeded 800,000 tons. He had tried rice straw for paper, but it was too costly, and not good enough. For the cultivation of rice in Arrakan they had been compelled to introduce labour from Chittagong, but where things would grow to give a profit, labour would follow. In the southernmost parts of the province, he was informed there was an abundance of Chinese labour, and he had no doubt that if sufficient inducement were offered to those industrious people they would make their way into other districts. Jute again showed the same wonderful development as rice. In 1861, the imports did not exceed 27,000 tons, but last year they exceeded 400,000 tons. Esparto had developed just in the same way. In November, 1856, a paper was read in that room by Dr. Royle, and the Society's *Journal*, containing the paper, was printed on esparto paper, which he (Mr. Routledge) had then first introduced. In fact, in 1860, he was the only paper-maker using it, whereas now 200,000 tons a year were used. It was now getting very scarce and dear; it had been almost exhausted in Spain; the same thing was occurring in Algeria; and he feared the result of the French interference in Tunis and Tripoli would be to put a protective duty upon it from there. Everything, therefore, pointed to the desirability of developing the resources of India and Burma, so that we might be independent of foreign nations.

Mr. F. Barlow said he had just returned from Burma, but his tour only consisted of a three months' hurried journey through the country, so that he was not competent to say much on the subject. He was most heartily received by Mr. Bernard and all the officials, and it so happened that he was included in the census in some out of the way village near the frontier, from which in fact many of the inhabitants had gone over the frontier, fearing something was going to happen to them from the census papers being sent round. No one had alluded to the Burmese themselves; but they were the most charming and interesting people he ever saw, except the Japanese, whom in some respects they much resembled. The women were exceedingly pretty, and dressed in the most graceful and becoming way. The men were always cheery and nice, and you became friendly with them at once; very different from the natives of India. Whether Mr. Routledge would get over the labour difficulty he did not know, but he never saw a Burmese man work at all; he made the women cut wood and draw water, and employed Malagasy labour to gather his produce and till the ground. The inhabitants of the hills were of a more barbarous type; their cultivation consisted in burning down great tracts of forest; and at present the Government was trying to confine them to given districts, so as to preserve the teak. In one district when he was there, they came and asked leave to burn the forest, and were told they might do so if they would plant young teak trees and keep them weeded; but this concession they declined, knowing that when once the teak was planted, it would be strictly preserved. He might, perhaps, say a word or two on the question of opium. He travelled with the Chief Commissioner over a great part of Burma, and at every village he turned into the opium shops to see what effect opium smoking had on those who indulged in it. Those who came out were certainly horrible looking specimens, but when you asked one who, from an extraordinary look about the eyes, was evidently a confirmed opium smoker, how long he had taken to it, the answer always was, just two months ago, whereas he had probably been indulging in it for something like twenty years. It was a question, he thought, whether a total prohibition of opium in a malarious country would be wise. It was probably a useful drug in its way, and with it, as with most other things, moderation would do no harm; it was the excess which did the mischief. In Burma he doubted whether it was excessively indulged in to any great extent; but he had only gathered his information second hand.

Mr. Christian Mast hoped he might be permitted, as a native of a foreign county, but as an Englishman by naturalisation, to express the great pleasure he had felt in hearing about a foreign country like Burma, and the way in which this province seemed to be administered. He had often listened to papers read in that room, but rarely with such pleasure to an exposition of the mode of action in a British province as he had that evening. Very often they had heard about spreading civilisation in a manner which, if analysed, was anything but civilisation; but, to-night, they had heard that the real means of civilisation, namely, education, commerce, and trade, seemed to be employed in Burma, and the rulers seemed also to

enter into the spirit of the people, and not to run counter to their inclinations. He was much struck with the skill with which the governor seemed to have found out what the people liked, and to have escaped running counter to their religious feelings, so that for once the English race went hand in hand, he would not say with a semi-civilised race, because the Buddhists were highly civilised, and their civilisation was older than the English, but with an old race, and he hoped it would always be so.

Sir Arthur Phayre, in reply, said he was glad to hear it stated that steamers had gone up from Mandalay to Bamau last year as usual, as it showed the trade with the frontier of China was likely still to go on, without any further interruption. The time he alluded to was 1879-80, when, according to his information, there had been no steamers. He had been asked, with regard to the literature of the Burmese, whence it was derived, and whether it had been influenced by the Chinese. As far as he knew, the ancient Burmese literature had not been influenced by China; but he spoke with great diffidence. He believed the Burmese were taught letters by Buddhist missionaries from India—probably from Gangetic India—but the present literature of the country might be said to be derived almost entirely from the Pali literature of Ceylon. From that, a vernacular literature had arisen; much as, they might suppose, the literature of England arose or had followed, from the Latin used in the Middle Ages. He had lately heard that remarkable discoveries had been made as to the extent of the Pali literature. While he was in the country, no researches were made on the subject; but, within the last two years, a German gentleman had been appointed Professor of Pali in the High School of Rangoon, and he had made some very remarkable discoveries as to Pali works existing in the country, and also as to translations into Pali from the Sanscrit, and again from that into the vernacular.

The Chairman said that, so far as his information extended, and certainly what Sir Arthur Phayre had adduced confirmed the impression, whatever discussions there might have been at the time, or difference of opinion as to Lord Dalhousie's proceeding in annexing the territory of Burma, the inhabitants had been only gainers by the process. Not only had their numbers more than doubled, but the commerce had quadrupled; in fact, there appeared to be all the evidence of improved government, and of the perfect freedom of development necessary to the welfare of the people. Certainly, if they had any doubts as to the mode of proceeding in different regions, it was a great satisfaction at least to know that there could be no question as to the results on the welfare and happiness of the people that came under our rule. Mr. Routledge had given some very interesting facts with reference to paper-making which had especially interested him, the "bamboo" being a very old friend of his. He had spent great many years in two countries where there was this singular state of things. In China, where rags abounded, they never used a bit of rag in paper, but it was entirely made of bamboo. In Japan, where also they had abundance of rags—in fact, they were a perfect drug in the market—they neither used them nor bamboo, of which they had plenty also, but the bark of the mulberry tree, with some twigs of other shrubs. The bamboo paper, which was well-known to artists many years ago, being specially favourable to fine proof impressions from copper-plate, was called India paper, because it was brought home in India ships; but it was really China paper, and there it existed to this day. That colossal empire, like other megatheria, moved very slowly, and had not shown the slightest dispositon to use either rags or mulberry bark. The bamboo paper had one objection, that it was exceedingly perishable and brittle; it tore with the slightest effort, whereas that shown by Mr. Routledge was cured of this defect. Japanese paper also, though often as fine as cambric, was almost as difficult to tear. Of course, both in China and Japan, the paper was made for Indian ink, which again was really Chinese ink. The Japanese, with their marvellous development of industry in the last ten or twelve years, had now got various paper mills on the European pattern, and made a good deal of paper entirely of rags or rag mixed with other ingredients. The Chinese, on the other hand, went on making their bamboo paper as they did 3,000 years ago, and for aught he could see, would go on doing so for another 1,000 years. Mr. Routledge's bamboo paper was much superior in many respects to that of the Chinese though they had been using it so long. He supposed it would be necessary to have crushing machinery wherever the chief supplies might be drawn from, in order to reduce the bamboo to some manageable condition for freight. The Chinese were rocked in bamboo cradles when they were young, fed with bamboo, and beaten with it when they were growing up; they lived under it in their houses, and, in fact, without bamboo one could scarcely understand how a Chinese population could exist. There did not appear to be any trace of race hatred or religious fanaticism in Burma, to prevent harmony between subjects and governors, as there were in China, where missionaries were continually being massacred, and their houses burnt over their heads. He had not heard of anything of that kind in Burma, and he presumed the Burmese were a more easily governed race, or had less race prejudices. They must all rejoice at the great progress which Burma had made under the auspices of Sir Arthur Phayre; and, in conclusion, he would propose a cordial vote of thanks to him for the very excellent and interesting paper which he had given them.

Sir Joseph Fayrer, F.R.S., said he was aware it was not usual to second the vote of thanks on these occasions, but he would ask leave to do so in order to say a few words. He could hardly express the great pleasure it gave him to be present that evening, when he thought of 28 years ago, at which period he had the honour of serving in Rangoon with Sir Arthur Phayre, the latter being the first Chief Commissioner, and he the first Civil Medical Officer. At that time he could hardly have anticipated that at so distant a period he should have had the great gratification of seeing Sir Arthur looking in such excellent health, and of hearing from him so gratifying an account of the country he had so admirably governed. The population had been doubled, probably more than doubled; the revenue had been quadrupled; everything had prospered. The nation was happy and contented, and had preserved its individuality. Its religion was undisturbed; the people had been peaceful and contented throughout the whole of that part of Burma which had had the good fortune to be under British rule. They might indeed congratulate Sir Arthur Phayre upon this state of things, as no one could doubt that it was mainly due to his administration.

The vote of thanks passed unanimously, and the proceedings terminated.

A paper on "British and Upper Burma," by Colonel W. F. B. Laurie, was printed in the *Journal* for June 11, 1880 (vol. xxviii, 640.) On p. 644, col. 1, l. 23, for "British Burma" should be read "Upper Burma."

TWENTY-THIRD ORDINARY MEETING.

Wednesday, May 25th, 1881; W. H. PREECE, Memb. Inst. C.E., in the chair.

The following candidates were proposed for election as members of the Society:—

Brearley, James Barnes, 77, Old-road, Middleton, near Manchester, and Jessamine-house, Barton-on-Irwell, Lancashire.
Groth, Lorenz Albert, 97, Finsbury-pavement, E.C.
Harrison, Samuel, 11, Queen Victoria-street, E.C.
Hesketh, Everard, Dartford, Kent.
Johnston, Thomas Ruddiman, 108, George-street, Edinburgh.
Lasseter, Frederic, 5, Porchester-gate, Hyde-park, W.
Pfeil, A. L. A., Frognal, Hampstead, N.W.
Wickham, William Henry, 14, Essex-street, Strand, W.C., and Wimbledon-hill, Surrey.

The following candidates were balloted for, and duly elected members of the Society:—

Betts, Edward Peto, M.A., The Holmwood, Bickley, Kent.
Clark, Robert Ingham, West Ham Abbey, Stratford, E.
Cottrell, James Maskall, 340, Brixton-road, S.W.
Glover, William, Tower Chemical Works, Victoria Docks, E.
Grant-Duff, Malcolm, Imperial-chambers, Bowlalley-lane, Hull.
Treloar, William Purdie, 69, Ludgate-hill, E.C.

The Adjourned Discussion of Mr. Alexander Siemens's paper on "Electric Railways, and Transmission of Power by Electricity," was resumed.

The Chairman said that amongst the numerous inventions which had characterised the past two or three years in the application of electricity to useful purposes, no one had yet succeeded in inventing a process by which the human body could be in two places at one time, and the absence of such an invention had prevented him from being present when the paper was read by Mr. Siemens, but owing to the admirable manner in which the proceedings of the Society were published, he had had an opportunity of carefully studying the paper. From one point of view, the paper reflected the very greatest credit upon its author, because it was eminently a practical paper, and dealt in an able manner with a very abstruse, difficult, and novel subject. Unfortunately, in the present day, there is a strong tendency to push practice on one side and to bring theory and imagination very much to the front; and this was especially the case with certain nations. In one particular country, practice was thrust aside, and the wildest imagination allowed to gallop in the columns of newspapers with the greatest possible nonsense. There was something in electricity that gave a latitude to the exercise of this imagination: it was something striking, something that at once, by its marvellous adaptation to the telephone, the electric light, and various other purposes, seemed to carry one beyond the practical age, to an age somewhere beyond the days of their grandfathers, and, as a result, they found, whenever any application of electricity was proposed, that a great deal of nonsense was talked and written. A few days ago a letter appeared in the *Times*, written by some enthusiast who happened to be in Paris, where he was introduced to a battery known as Faure's secondary battery. He described briefly this wonderful battery, and after travelling night and day to Glasgow, and depositing it with Sir William Thomson, it was described by that gentleman as "a little witch." This battery had attracted attention, because people had been led to imagine that it was a process by which electricity could be stored, carried about, and utilised for various purposes. Recently, when in Paris, being somewhat of a practical turn of mind, he (the Chairman) examined this battery carefully, and came to the conclusion that there was not much in it. The battery had a pretty high amount of force, being equal to about 2¼ Daniell's cells, but it was a battery of very low internal resistance, and, therefore, able to give a considerable current. In all questions of this kind where electricity was applied, a very important element was introduced, viz., the element of time. It was perfectly feasible and practical to produce a powerful current of electrity that would last a minute, or even three minutes, but for lighting and tramway purposes, or the ordinary power purposes in arts and manufactures, they wanted something that would last a very much longer time. This particular battery, that was supposed to store electricity, lasted but a short time; it gave a powerful current, it was a pretty thing, but it was not at present practical. Again, to illustrate the fact that imagination rather departed from practice, he might mention that, not long ago, a paper was read before the Society by no less an authority than Professor Perry, in which he said that he believed that, at no distant date, they would have great central stations, possibly situated at the bottom of coal pits, where enormous steam-engines would drive enormous electric machines; that wires would be laid along every street, and tapped into houses like gas, and registered by a meter; and that electricity would be used for driving machinery as well as for giving light. Now, judging from practice, he thought there was about as much probability of such a state of affairs arising in this country, as there was of being able to emulate the example of the young ladies mentioned by Bulwer Lytton, who put wings on their shoulders, and floated about beautifully in the air. There seemed to be in the present day a great tendency to ignore experience. He had been personally engaged in the practical application of electricity for over 30 years, and scarcely a day passed without his dealing in some shape or form with electric currents, consequently he might fairly claim to have some practical experience in the application of electricity; but on mildly venturing to suggest that a certain firm engaged in establishing the electric light was committing what might be regarded as a crime in the telegraph world—he was told that telegraph men knew nothing about electric light currents. Now, if anyone did know anything about electric currents and the disturbance to which currents were liable, they were telegraph men; and in the question of the transmission of force to a distance, and the application of electricity to certain purposes, he thought there was some experience in the telegraph world which might be of service. For instance, it was proposed to transmit to a distance currents for the production of electric light and for the production of power. Many persons were aware that on previous occasions he had spoken of the application of the electric current to lighting purposes, and had thown some cold water upon it, for the simple reason that the experience of telegraphists showed that it was impossible, with their present knowledge, to distribute electric currents through towns and other places, so as to carry out the dream of the projectors of electric lighting enterprises. The question of the transmission of power was an entirely different matter, and the difficulties in its way were of a totally different kind to those attaching to the unlimited division of the electric current. He maintained that the sub-division of the electric light with the notion of entirely supplanting gas was as futile and as absurd as the philosopher's stone. Although there were difficulties surmounting the transmission of electric current for the purpose of the transmission of power, still they were not so great, the chief reason being this, that to distribute light over a large area, or through a town or a number of houses, you must have a very high electric motive force; whereas to distribute the electric current for the purpose of producing power you did not want a high electric force. High electric motive force meant danger to the wires conveying the currents, as had lately been seen in the case of one of the companies now illuminating the City, the electric current having broken down the wires. Having said something on the merits of Mr. Siemens, it would now be as well to make what remarks

he had to make in criticism of him. He liked his paper, but he did not like his mathematics. He would not go very deeply into that point, because it would doubtless be considered a bore by the audience. The mathematical part of the paper seemed to be based on the labours of Dr. Frölich; but here was introduced a term which seemed to require some explanation, which he hoped Mr. Siemens would be able to give. That was the use of the term "effective magnetism" to express what was in reality electro-motive force. The electricians present would feel that that to apply a function of electro-motive force as an effect of the machine was to commit what logicians called an anomaly magnestism. Again, to explain something which was very simple in itself, he had been compelled to introduce what were called Foucault currents. These currents were currents created by the author to account for certain effects of heating observed in the armatures magnetised; but he thought what took place could be explained better by another well-known cause. It was shown in the paper that there were certain relations existing between the power put into one machine, and the power taken out by the other; and the whole practical value of the paper, and of the transmission of power by electricity, depended on the exactitude of these formulæ. He did not question the formulæ themselves—they were perfectly exact, but he wanted to enlarge them a bit in order to explain the anomaly which was found there, for which Foucault's currents had been invoked. If you had an armature wound with wire, revolving at a given velocity, and springs pressing against it to take up the current produced by the rotation of the armature between the poles of a powerful magnet, either a permanent or an electro-magnet, the wire from one of these brushes might go to earth, the other might be attached to the wire of one coil of an electro-magnet, and pass through the other coil, and then through a wire of any length to another similar apparatus, with a rotating armature and springs, and then to earth. In the one place magnetism was produced, and a coil of wire rotated with great velocity within the sphere of that magnet. The result was that currents of electricity passed along the line wire, it might be 100 yards or 10 miles, and then they came to another armature, precisely similar to the first; they passed through it, through the coils of the field magnet, where they produced magnetism, and established a field which produced mutual reactions between the currents of magnetism, and thus caused the second armature to rotate. [Mr. Preece drew a diagram on the black board to illustrate his meaning.] It was the rotation of the second armature which was utilised as power to turn machines, drive railway trains, and so on. He would point out that there was a certain relation between the power applied to the first machine, called the generator, and the power developed in the second machine, called the motor. The electric current developed by these machines was an exact measure of the power put into the machine, so that a proper instrument of this kind would be one of the most accurate and exact dynamometers a mechanician could use for small powers. Now the relation between the first machine and the second was given by a very simple formula. You could find anywhere the horse-power expended in the circuit by multiplying the electro-motive force by the current in the circuit, and dividing it by the resistance. In the second machine the electro-motive force was called E_2, and the formula showing the amount of work was—

$$W_2 = \frac{E_2 (E_1 - E_2)}{R}.$$

In the first place there was the coil rotating very rapidly by direct application of mechanical force in the field of a magnet, which produced the electro-motive force E_1. This produced a current through the system, and this caused the second armature to rotate. But it rotated in the opposite direction, and by so doing it set up a counter electro-motive force, and therefore the current in the circuit was produced by the difference between the two forces; and so they got the above equation. Now, since E_2 is a variable, we can differentiate the above equation with respect to it, and by putting its differential co-efficient = 0, we obtain the maximum result which could possibly be obtained. This occurs when $E_2 = \frac{E_1}{2}$. There was force put into the generator to obtain an effect in the motor; and it was impossible that the rotation of the second could equal the first, because then there would be no current at all; therefore the rotation of the second machine must be less than the first. On the other hand, the rotation of the first must be pretty rapid, or there would be no work at all. It followed, from the formula he had given, that to produce the maximum effect, the electro-motive force in the motor machine must be exactly half that in the generator. Applying that to Mr. A. Siemens's figures, they found that the useful effect of every machine was at a maximum when the electro-motive force of the motor was half that of the generator, when the velocity of rotation of the motor was half that of the generator, and when also the work done in the one was just half that of the other. Dr. Hopkinson and others had shown that in a Siemens dynamo machine you had 90 per cent. of energy converted into electro-motive force, and they had heard it proved that the power given out by the second machine was half that of the first. The result was, if you put 5 h.p. on to the first machine, you got a little less than 2½ h.p. in the motor. In fact, half 90 per cent. was 45 per cent., and that was about what Mr. A. Siemens said was the amount of force given out. He had shown them that it ought to be so, and, therefore, there was no necessity for conjuring up imaginary Foucault currents to account for the result. Mr. A. Siemens, however, was quite correct when he stated that it would still be economical to have large stationary engines to work small motor engines at a distance, because large engines only consumed 2½ lbs. of coal per h.p., whilst small ones used five or six pounds. But there were difficulties to be overcome. As regards distance, that was nothing; the effect of distance could be easily got over; but there was a serious difficulty when you came to a number of small motor machines. All these theories were quite true when you were dealing with one machine driving another machine; but when you talked of wires being laid along the streets, tapped into houses like gas-pipes, you introduced not one opposing force, but a dozen, or it might be 500; and here the practical experience of the telegraphist came into play. They knew what it was to introduce many instruments on one circuit. When there was only one instrument on a circuit, they worked at 250 or 300 words a minute, but when they came to apply intermediate stations and additional instruments, the speed ran down by the introduction of that same counter electro-motive force, and the effective force was reduced accordingly. There were other difficulties to which he would not stop to allude. He would conclude by again expressing his sense of the value of Mr. Siemens's paper.

Dr. Siemens, F.R.S., said Mr. Preece, with his well-known ability, had just shown that the power to be obtained from the motor machine could not exceed one-half that communicated to the generator. That, however, was a question which had been much discussed amongst electricians, and Mr. A. Siemens had adopted the safer course, of rather under than over-stating the results, which might be and had been obtained. There was by no means such a limit as 50 per cent. Experiments of undoubted accuracy had shown that you could obtain 60 or 70 per cent., and that the point of maximum effect was not limited to half the velocity; though he quite agreed with Mr. Preece that there was a limit. If the velocities were equal theoretically, the maximum result should be obtained, but the counter current produced

in that case was also a maximum, so that practically the maximum lay between the two results of half velocity and equal velocity. He had in his hand a report, received only that day, with regard to the working of the little railway at Berlin, in which his brother put it, as the result of observation and measurement, that 60 per cent. of useful effect was realised; but this was under very peculiar conditions. And it was one of the remarkable features connected with the electric transmission of power, that as the resistance to be overcome in the railway carriage increased, so did the force increase to overcome the resistance. Thus, in going on a level, the power used to propel the train might be 10 h.p.; but when the train ascended a gradient of 1 in 80, which was the steepest on the line, then the power necessary to drive the dynamo machine at the station increased, and the power transmitted to the carriages increased in a still greater ratio. Indeed, it was a surprise to everyone who had investigated this little railway to see with what determined force the carriages ascended the incline, with comparatively little decrease of velocity. Of course, in order to overcome the greater resistance, the velocity had to decrease. It was stated in the paper that the velocity of the train had been limited to ten miles an hour; but, seeing the facilities with which the train ran, greater speed had been allowed, and the carriages had gone to the distant station and back in seven and a-half minutes, which meant an average speed of about twenty-five miles an hour. A difficulty had arisen, as happened with most new inventions, and this difficulty was of a most peculiar kind. In the Berlin railway, one rail conducted the current towards the carriages, and the other took it back to the station. Now, if a man passed over the line at a level crossing, no harm was done, because he put his foot on only one rail at a time; but a horse being endowed with four feet, he sometimes put one foot on one rail and another on the other, and thus experienced a most inconvenient shock, so much so, that horses decidedly objected to these level crossings, and it became necessary to make some special arrangements to avoid this inconvenience. It sufficed to put one rail at the crossings out of circuit, and to connect the backward and forward rail electrically. This experiment showed the practicability of the system, but his brother entirely agreed with him that it was not by any means to be supposed that the electric railway would banish locomotive engines from our great thoroughfares. The electric transmission of power would be efficacious, no doubt, for local traffic, such as tramways, and also for lines conveying minerals from the interior of a mine to the bank, and in exceptional cases for the transmission of heavy trains along rails. One of these cases was presented by the St. Gothard Tunnel. The company to which that belonged were fully alive to all modern improvements, and had requested them to work out a plan for utilising the hydraulic power, which could be had in great abundance near the mouth of the tunnel, for the passage of the train through the tunnel. By the accomplishment of that object, very great advantages would be gained; for, as those who had travelled through the Mont Cenis Tunnel, or through the one on the line between Alessandria and Genoa, were aware, great inconvenience resulted from the emission of the products of combustion from the engines during the transit. If a train could be sent through this long Alpine tunnel by electric force, a great inconvenience would be saved to the passenger, and at the same time a great saving would be effected for the company. Nearer home there was a case which would lend itself admirably to electric transmission—the Underground District Railway. All those who were in the habit of using that railway appreciated the facilities it offered in going to the City or from it; but they also felt the inconveniences of the products of combustion choking the atmosphere. Plans had been proposed for more thoroughly ventilating the tunnel, but they were only palliatives; the cure would consist in finding a source of power without the inconvenience of combustion being carried on in the tunnel. A plan had been proposed for working the engines by compressed air, and he had nothing to say against it, but it did not do away with the necessity of having an engine nearly as heavy as the present locomotive. He believed if electric transmissions were tried on that railway in such a way as to make the rails act as the return conductor, making them all "earth," and fixing guide rails under the roof for the conveyance of the current, to be taken into each carriage by means of a metallic rope, great certainty of action would be obtained, and the trains would be propelled through the tunnel without fear of their being stopped midway, and at a very economical rate. These were the features of this innovation; that it lent itself to the conveyance of power to any reasonable distance, and that it could be applied without any of those inconveniences which now beset our locomotive traffic. He hoped that before long a trial would be made of the system, not, perhaps, on a very large scale at first, but sufficient to show its merits.

The Secretary said he had written to Sir William Thomson, with a view of having the secondary battery which had been alluded to shown; but Sir William informed him that he and Mr. Bottomley were engaged on a series of tests in connection with it, and, until they were completed, he could not let it leave Glasgow. Otherwise, he would have been very pleased to send it.

Mr. Hale was not very sanguine that this method would answer for the Metropolitan District Railway. The line was not all tunnel, and he did not understand from Dr. Siemens whether he intended trains only to be taken through the tunnel by electricity, and then on by an ordinary locomotive; but, if so, that would be a great obstacle and delay. The locomotives were very heavy, and even the carriages weighed 12 to 14 tons each. Again, did he understand that the influence of the transmitted power would be as great 30 miles from the central station as a few miles only? It occurred to him that that was, at present, only theory. He should like to know the weight of the carriages on the Berlin line, and if the figures quoted of the cost were absolutely exact.

Mr. J. N. Shoolbred wished to add a word or two to what he had said last week in regard to the efficiency of electrical machines. Dr. Hopkinson had read a paper at the Institution of Mechanical Engineers, as to the efficiency of electric machines, as Mr. A. Siemens had stated; but a year later, Mr. Gray, of Silvertown, had also given the result of a similar series of experiments, which he had carried out during the interval with a Gramme machine, the one used by Dr. Hopkinson being a Siemens. On the wall were two diagrams, showing the results of each series of experiments, and it would be observed that there was a wonderful similarity between the curve shown as developed by the Gramme machine, and the curve shown by Mr. Siemens, as the result of experiments carried out on a similar machine by Meyer and Auerbach. The peculiarity about it was the sudden dip at a certain point, near the end, which Dr. Hopkinson suggested must have been due to a slip in the driving band, or some accident of the kind. Mr. Gray, however, felt quite certain that such could not be the case, but "that it was due to the magnetism of the field magnets falling off, after the external resistance had been reduced beyond a certain point; and was somewhat analogous to the action in a battery due to polarisation. This effect would be produced in a Siemens's machine only when the external resistance, had been still further reduced than in the case of a Gramme machine." The curve of Dr. Frölich's experiments on the Siemens machine also confirmed the accuracy of this statement. With regard to Mr. Preece's remarks, he had long hesitated about accepting the dictum that the loss of power must neces-

sarily be 50 per cent., and he must now decline to accept it, especially as the opposite view was confirmed by the remarks of Dr. Siemens and Professor Ayrton. Generally, two machines of similar construction had been used, but if instead of that the secondary machine was of a lower electro-motive force, you would thereby increase the difference on which the effective result depended. Some time ago he had occasion to try experiments with different sized machines, and he at first drove with a large machine using a large amount of mechanical power, but with a low electro-motive force; whilst the secondary machine, being smaller, had a higher electro-motive force. He then reversed the machines, and drove from the smaller machine, which required a smaller amount of energy, but which possessed in its internal construction a higher electro-motive force than the bigger machine; and the same amount of work was then done with a smaller expenditure of mechanical energy. Consequently, in the second case, where a machine with this lower electro-motive force was the driven one, you got a better result than in the first instance. The main point was to get as great a difference as possible between E_1 and E_2, but you could obtain that not merely by difference of speed, which could be obtained with two machines of the same kind, but also by employing two machines having each a different electro-motive force. Speed was a matter which settled itself according to the load. A high speed in the generator meant a large amount of power; a low speed in the motor meant that it was doing a large amount of work. What Dr. Siemens had said about the effect of inclines on the railway, came to much the same thing. It had been explained by Dr. Siemens in a very interesting way in a paper read before the Society of Telegraph Engineers. The difference of potential between the two machines was at a maximum when the second was at rest; the moment it started, it went at a tremendous velocity, and until they settled down to work, it increased in velocity. The effect of ascending the incline was to throw more work on it, diminishing its own speed, and, consequently, the augmenting potential of the other one. He would refer anyone who was interested in the subject, to this paper of Dr. Siemens, where it was most clearly explained.

Mr. Donnithorne said he had noticed a spark at the point of contact between the wheel and the rail last week, and he wished to ask whether there would not be a loss of power in consequence.

Mr. Bright (Mayor of Leamington) asked whether there would not be a danger in wet weather of the electricity passing from one rail to the other, in the same way as when the horse stood upon it.

Mr. Dipnall asked whether this system would be applicable to large ocean steamers and purposes of that sort.

Mr. Clements thought there was not any great difficulty in understanding this subject, especially as there was a railway now in operation, which would give great encouragement to the opening of other railways of a similar kind, which he hoped might be tried. They all knew the great difficulties which the present railway schemes had to contend with at their inception, especially from the immense Parliamentary expenses, and perhaps these might be saved in the case of electric railways. He referred to the various difficulties which beset ordinary railways, and thought the present gauge was too wide. It would also be a great advantage if the power of water could be utilised as had been suggested.

Mr. Crompton, being called upon, said he had used the transmission of power by electricity experimentally in lectures, and for such purposes, and had driven machines at a distance, but he had not measured the power employed at the generator, or given out at the motor; and without such experiments he did not feel that he could add any valuable information to what was already before the meeting.

Mr. A. Siemens, in reply, said he would not weary the audience very long with replying to objections to the theoretical part of the paper, and would answer Messrs. Ayrton, Shoolbred, and Preece, all in one. To begin with, it was true he had applied the letter M in his formulæ to electro-motive force; that was because he already had two letter E's, and he thought it would be clearer if he followed the example of Dr. Frölich, and called this electro-motive force unit M; it was merely not to have too many letters E in the formulæ. Mr. Preece had very ably explained how he arrived at the equation he had given, but he had overlooked that the same equation had been given in the paper, and the diagram on the wall showed that the work done in the second machine was equal to a constant multiplied by the electro-motive force of the second machine multiplied by the current. The current was equal to the electro-motive force of the first machine, less the electro-motive force of the second, divided by the resistance, and if you replaced C, by this expression, the equation would be the same as that given by Mr. Preece. He had hurried over the theoretical part of the paper, because he did not want to be too scientific in a Society devoted to applied science. As regards Mr. Shoolbred, the suggestion that the difference should be as great as possible between the two machines was not correct, as according to mathematical rules the product is a maximum when E_2 is exactly half of E_1; he therefore could not agree that the second machine should have as low an electro-motive force as possible. Professor Ayrton and Mr. Shoolbred recommended machines with permanent magnets, instead of dynamo machines, but he could not agree in that view, and they all knew that these magneto machines, although known for over 40 years, had never been used for transmitting power. That fact alone showed that they were not fit for the purpose. As regards exciting all dynamo machines by separate exciters, that had also been treated in the paper, by Dr. Frölich. Mr. Preece rather doubted the presence of the Foucault currents, and seemed to think that Dr. Frölich or himself was the originator of them, but that was not so. In some machines they had light bobbins revolving in a powerful magnetic field; they began by protecting those bobbins to keep them in shape by putting small copper plates on each side, and they then found that simply turning the machines, without closing the outer circuit, took very great power, and that these plates got very much heated, although there was no current whatever passing through the wires of the bobbins. It was simply the Foucault currents circulating in the metal plates on the two sides of the wire, which created this heat, and made the exertion of power necessary. The same thing happened if, in a dynamo machine, the iron armature was quickly moved in a magnetic field. He might also say that the method Dr. Siemens had alluded to of having separate leading wires suspended overhead, instead of using two rails for the two leading wires, was going to be applied to a tramway in the suburbs of Berlin, where a small carriage would run on the wire and be connected with the ordinary tram-car by a metal rope, the ordinary rail of the tramway serving as a return conductor. That would at once answer one of Mr. Hale's questions. If such an electric railway were to be applied to the metropolitan lines, the wires connecting the current to the carriages would be suspended in the tunnel just under the roof, and between the tunnels they might be supported on poles. It had been said that it would be very difficult to distribute the current in houses, because you had not to deal with the simple question of having one machine generating the current and another utilising it, but you might have a lot of machines, some going and some not. He

had not gone into the details, because he wished to keep his paper as practical as possible. As regards heavy trains on the Metropolitan Railway, it would not, of course, be possible to take one of the small machines he had shown to pull a heavy train, but it would be quite practicable to construct more powerful machines for the work. Dr. Siemens had mentioned that there was a scheme on foot for running trains through the St. Gothard Tunnel by electricity; in that case they would have to have a locomotive to replace the steam locomotive at the mouth of the tunnel, so as to utilise the same rolling stock; the electro-motive motor would be just as heavy as the locomotive, and would have the same adhesion, and there was no difference to the passengers in the train. He understood that locomotives were often changed on English railways, and in the case of the express which went to Scotland, the passengers took refreshments while the operation went on; if, therefore, the time lost in exchanging locomotives were the only difficulty, they might make a refreshment-room at the mouth of the tunnel, and then no one would complain; but, of course, on the metropolitan lines, special rolling-stock could be employed, and a special dynamo machine could be put on each carriage, and then trains could be made up in the usual way, long or short. Of course, he could not go to-morrow and run an electric train on the Metropolitan Railway, or even lay a full scheme before the authorities for the purpose; what he wanted to prove was that the electric transmission of power had made a great deal of progress during late years, and was applicable in certain circumstances, and would no doubt be applied. As to the distance from the stationary engine, the resistance in a circuit was so small that it would make practically no difference if it were extended to thirty miles. As regards the cost of the railway, that was the only part of the paper where he had dealt with estimates, and not facts. The items, of course, were got out with the greatest possible accuracy, but according to Berlin prices, where labour, and also iron, he believed, is cheaper than in England. Another question put was as to what would happen in wet weather. The line from Lichterfelde had worked exceedingly well in such weather. It had excited a great deal of curiosity, and a deputation from the Society of Railway Engineers of Germany paid a visit to it, and fortunately they came in wet weather, when the rails were rusty and the ground quite damp. The tension, however, of the current being so very low, the resistance of the wet ground was still sufficient to keep the insulation, and the car ran along just as if it were dry weather. If overhead conductors were used they could be insulated, as the present telegraph lines were, and wet weather would have still less influence. With regard to the little machine showing sparks on the railway, that was due to its small weight, if it had been heavier the wheels would have made better contact with the rails, and no spark would have been seen. He did not think the electric transmission of power would be suitable for steam-ships because you must have some power to work the primary engine, and a secondary machine below to work the propeller, and if you had a steam-engine on board it would be more advantageous to apply it directly to the screw. The only other way out of the difficulty would be to have a stationary engine on shore connected with the ship by a cable, and then it would be very awkward if the cable broke. It had been said by several speakers that if the secondary machine was turned with the same speed as the first, E_2 would equal E_1, and there would be no current. Being of a practical turn of mind, he thought it would be as well to try that, and so he had two machines tried, the first one running at 684 turns per minute, the secondary machine, running loose, ran 730, or 46 turns quicker than the first, and at that time there was a current of three webers going through the system. Then he had a brake applied to the second machine which brought it down to 652 revolutions, a little slower than the first, and then the current increased to 7·8 webers. Then he had another experiment made, because he thought it might be objected that the first machine had a greater or smaller electro-motive force than the other; he therefore reversed them, and made the secondary one the primary, it was then driven at 682 revolutions, there was a current of 4 webers, and the second one ran at 755, or 73 quicker than the other. Then, again, he applied the brake, and he found the primary machine ran at 690, and the second at 684, there was a current of 7·8 webers, and a little bit of work done, ·07 h.p. This seemed to contradict theory; but he thought the explanation would be found in the mode in which the brushes were applied to the revolving armature; because, when applied in the most efficient manner, for the machine turning in one direction, they would be not properly placed for obtaining the greatest effect when the direction was reversed. Therefore it was possible to drive the second machine a little quicker than the first, although the theory seemed to prove that it was impossible.

The Chairman, in proposing a hearty vote of thanks to Mr. A. Siemens, for his able and practical paper, said the weight of the carriage was not of much consequence; if the carriage weighed 20 tons, it would require 160 lbs. to pull it; and inasmuch as by the system of electro-dynamo machines, they could, without difficulty, transport to a distance of 20 or 30 miles, as the case might be, from 5 to 10 h.p., it was quite evident that whatever might be the weight of the carriage, Siemens's currents would be strong enough to move them quite fast enough. He was afraid that Mr. Alexander Siemens, at one time, was going to upset his own theory, for he proved that, when the machines ran under certain circumstances, these ran at nearly the same velocity; in some instances, the second machine ran faster than the first, but he took care to let it be known that the second machine was doing no work. Now, it was well known that one could not have his cake and eat it too, and if you had a machine, as the second machine, driving a wagon, the power could only be utilised at the expense of power absorbed elsewhere. If you put a 5 h.p. into the machine at one point you would, under the circumsances, only get $2\frac{1}{2}$ h.p., the other $2\frac{1}{2}$ h.p. being absorbed in heating the machine. Notwithstanding what Mr. Shoolbred had said, he was prepared to stand on the formulæ he had given as being correct, according to experiments which had been made, and, moreover, it accorded with facts. The advantages in favour of electricity were the ease with which the power could be transported from place to place, the cheapness with which it could be utilised to different purposes, its freedom from danger, and, above all, it fulfilled to the very highest degree one of the principal duties of the engineer, namely, the utilising for the benefit of mankind the waste forces of nature.

The vote of thanks having been unanimously accorded, the meeting terminated.

MISCELLANEOUS.

ART FURNITURE EXHIBITION.

The private view of the Exhibition of Works of Art applied to Furniture, promoted by the Society of Arts, in connection with the Fine Arts Exhibition at the Royal Albert Hall, was held on Saturday, 21st inst., and the Exhibition was opened to the public on Monday, 23rd inst.

The objects are arranged in a series of twelve bays in the galleries round the hall, each bay being arranged by a particular firm.

Bay No. 1 contains a cabinet of carved walnut-wood, an octagon table of the same, a cabinet of satin-wood, and chairs, exhibited by Messrs. J. G. Crace and Son, besides stained glass by Messrs. Heaton, Butler, and Bayne, and china by Messrs. Minton and Co.

Bay No. 2 contains a screen showing the side of a room decorated in the English style of late 18th century, with silk in the panels, and an oval mirror in a gilt frame of same period on the centre of panel; satin-wood cabinets, pole-screens, and arm-chairs, marqueterie writing-table, mirrors, &c., exhibited by Messrs. Morant, Boyd, and Blanford; also three dishes of gold lustre-ware, by Mr. William de Morgan.

Bay No. 3.—The walls and ceiling are decorated in the Louis-Seize style, and the bay contains a cabinet and chimney-piece in the Oriental Greek character, composed of boxwood, ivory, pear, ebony, and other woods; several other cabinets, tables, chairs, &c., and various specimens of old Japanese lacquer, and Chinese and Japanese ornaments, exhibited by Messrs. Jackson and Graham; also wrought-iron dogs, by Feetham and Co., and combination gaseliers in ormolu, and cut-glass, by Messrs. F. and C. Osler.

Bay No. 4.—Messrs. Gillow and Co. show part of a room in the Italian style. The walls are hung with green velvet, the embroidered borders executed from designs of the firm by the School of Art Needlework. The Oriental carpets and curtains from Messrs. Vincent Robinson and Co. The chased metal works and ornaments by Messrs. Elkington and Co. Painted vases and tazzi, in the Italian style, by Messrs. Minton and Co.; and the Doulton ware and painted plates, by Messrs. Doulton, Lambeth. The stained glass window from the Royal Stained Glass Works, Windsor, and cut-glass, and chandelier, supplied by Messrs. Webb and Co., of Stourbridge. Messrs. Gillow exhibit mantelpiece, carved walnut secretaire, satin-wood cabinet, tables, seats, tripods, &c. Wood carvings of birds, of a Shakespeare cabinet, and of the head of Shakspeare, by Mr. W. Perry.

Bay No. 5.—Messrs. Holland and Sons exhibit a *dressoir* for dining-hall, of oak, inlaid and relieved with gilding, the centre of canopy surmounted by a tablet with carved subject, and mottoes from Pericles, the metal work entirely of hand-wrought brass, designed by the late B. J. Talbert; a cabinet in ebony, designed and partly executed by Barbetti, of Florence, and a writing-table.

Bay No. 6.—Messrs. Howard and Sons exhibit a special treatment of wall elevation and embroidery, cabinet work and parquet flooring. The Barberini and Milton vases in carved glass, are exhibited by Mr. P. Pargeter.

Bay No. 7 contains a specimen of wall decoration of the 18th century, after the style of the Messrs. Adam, a mahogany inlaid sideboard, and cylinder writing-table of the same period, a pianoforte case of marqueterie work of Louis XV. period, mahogany writing-table of the 18th century, after "Chippendale," and various specimens of carving and gilding, all exhibited by Messrs. Wright and Mansfield.

Bay No. 8 contains *dressoir*, mantel-piece, chairs, and other decorative furniture exhibited by Messrs. Collinson and Lock.

The corridor contains specimens of Doulton ware, exhibited by Messrs. Doulton and Co., consisting of terra-cotta panels, designed and executed by Mr. G. Tinworth, decorative panels by Miss Jane Atkinson, tiles and plaque by Mr. Edward Sears; also stained glass by Mr. Sears, and Algerian carpets worked by hand by S. Moline, of Algiers.

Bay No. 9.—Messrs. Gregory and Co. exhibit a collection of cabinets, tables, chairs, &c., in solid rosewood, of the modern English school. Turkoman tapestry, curtains, and *portières* of a special manufacture, suitable for rooms where Oriental carpets, &c., are used.

Bay No. 10.—Messrs. Shoolbred and Co. exhibit carved cabinets, tables, mantelpiece, aud other art furniture.

Bay No. 11.—Messrs. Johnstone, Jeanes, and Co. exhibit carved Italian walnut buffet, and dining-room chair to correspond, walnut panelling for side of dining-room or hall, and specimens of stained glass. The china in this bay is shown by Messrs. Minton and Co., and the metal work by Messrs. Perry and Co.

Bay No. 12.—The School of Art Wood-Carving exhibit a copy of 18th century English mantel-piece, 3 feet deal moulding, executed by Miss M. L. Irwin, two pilasters by Miss F. E. Rowe and M. Young, the fittings by Messrs. Feetham and Co. Mr. Sidney Phelps exhibits panels of a balcony, two pairs of sconces, and a pair of fine dogs in iron-work. Mr. F. Gleeson exhibits an ivory fan mounted with Mechlin lace, and carved fan sticks in mother-of-pearl, ivory, tortoiseshell, and pearl and ebony. Messrs. Morton and Co., of Edinburgh, exhibit examples of Tynecastle tapestry, a new fabric for the covering of walls, &c., the invention of Mr. W. Scott Morton. Mr. Thomas Jacob exhibits two ornamental cabinets.

With reference to the award of the Society's medals and certificates, it has been decided that the names of the designers and art workmen who have been engaged in the production of the art manufactures now exhibited, shall be given to the jury appointed to award the medals and certificates of the Society of Arts, and that the names of those to whom the awards are made shall be published in the *Journal.*

The Council of the Royal Albert Hall have agreed to present each member of the Society of Arts with a non-transferable season ticket, and any member wishing for such ticket can have one on application to the Secretary, Society of Arts.

THE PROPAGATION OF SPONGE BY CUTTINGS.

By C. G. Warnford Lock.

In a recent report on the Bahamas (see *Journal*, December 31, 1880, p. 102), Professor Ray Lankester called attention to the account of the efforts made by the Austrian Government to improve sponge culture in the Adriatic, published by Dr. Emil von Marenzeller in the Transactions of the Zoological-Botanical Society of Vienna." The following abstract from the German original will, doubtless, have an interest for many readers of the *Society of Arts Journal*:—

The history of the experiments, Dr. Marenzeller dismisses in a few lines. Professor O. Schmidt, in an article in the *Wiener Zeitung*, and in his work on the Adriatic sponges (both in German), expressed a conviction that, if a perfectly fresh sponge were cut into suitable pieces, and these were again placed in the sea, they would grow, and in time become perfect sponges. This was put to the test by an experiment conducted in the Bay of Socolizza, on the north-east point of the island of Lesina, commenced in 1863, and concluded in November, 1872. Success was rendered impossible by the unceasing disturbance of the locality with fishing nets, and even by actual robbery of sponges and apparatus. The pile-worm, which contributed to the mischief by destroying the woodwork used, was harmless in comparison with the determined opposition of the local populace, inspired by a deep prejudice against the innovation. These unfortunate circumstances, however, did not prevent the accumulation of a mass of valuable information, well calculated to form a basis for the repetition of the attempt under more favourable circumstances elsewhere.

The most suitable season for commencing the propagation is the winter. The growth of the sponge, and the healing of the cut surfaces, proceeds much more slowly in winter than in summer; but a high tempera-

ture is dangerous, by reason of the great tendency of the sponge to undergo rapid putrefaction. In winter, a living sponge may remain dry for several hours; in summer, it is ruined in a few minutes after leaving the sea, especially if not constantly supplied with fresh water. Buccich placed some sponge cuttings for eight hours in a shady airy place, at a temperature of 7° R. (48° F.), in the month of February, yet all grew.

As to locality, choice should be made of bays sheltered from strong waves and currents, but not quite still; the bottom should be rocky, and clothed with living algæ; and there should be a moderate ebb and flow of the tide. In all cases, the neighbourhood of the mouths of brooks, rivers, and subterranean springs must be avoided. The freshness and liveliness of colour of the marine algæ are sure indications of a suitable spot. The worst enemy of sponge culture is mud. Under certain circumstances, the seclusion of the bay by means of a chain across the entrance is to be recommended.

The sponges chosen for cutting must be gathered by experienced hands, with all possible gentleness. They are removed either by tongs or by drag-nets. One arm of the tongs is fixed to a long stake, the other is movable, and can be advanced towards the first by a noose, thrust down the stake by the collector; objects coming between the crimped ends of the tongs are thus held fast, and can be drawn up to the surface, of course only from a slight depth, such as the eyes and the stake can penetrate to. The sponges must either (and this is the most critical point) be taken up with their roots entire, or they must be torn from them, whereby a prejudicial squeeze or serious wound may very easily be inflicted. It was found at Lussin and Lesina, that when the men used one of O. F. Müller's or Ball's drag-nets, or even a net resembling the "trawl" of the English and American deep-sea fisheries, the sponges were nearly always brought up in good condition. It is also very very important, when collecting sponges for subdivision, to make a certain selection, as the malformed and commercially worthless specimens are as well adapted to this purpose as the best shaped. Such of the latter as are brought up should be left intact, and prepared for market. The raising of sponges by means of the tongs presents the additional objection that the operation can be performed only when the surface of the sea is perfectly smooth. The sprinkling of oil on the surface is not sufficiently effective for the purpose of rendering it smooth. Buccich, therefore, devised a simple apparatus, constructed as follows:—A tin box, 32 c.m. ($12\frac{1}{2}$ in.) square, has a glass plate fixed in the bottom; on placing the box on the surface of the water, the bed of the sea becomes visible. [The Greek sponge-fishers make use of a zinc cylinder, 37 c.m. ($14\frac{1}{2}$ in.) in diameter, and 50 c.m. ($19\frac{1}{2}$ in.) high, with a glass plate in the bottom, and sink it half-way in the water. The sponge-and pearl-fishers in the Bahamas and Panama employ a closely similar apparatus for a like purpose.]

Buccich found that it was not judicious to throw the sponges gathered from time to time into one common receptacle, there to await the cutting operation, as they very readily took injury, by the pressure and by the jolting together. He therefore adopted the plan of fixing them temporarily, with wooden pegs, to the inner side of a sort of fish-basket, fastened to the tow rope of the boat whence the fishery is being prosecuted. If any sponge is injured, the damaged portion must be cut away; the rest is pegged up, either in its entirety, or when cut into pieces.

At a low temperature in the cold season of the year, it is possible, with sponges freshly caught on the spot, to proceed at once to make cuttings from them; whilst during warm weather, it is necessary to wait and see whether any signs of putrefaction make their appearance. This reveals itself by the dullness and softness of the affected part. When it happens, further observation is needed, after cutting off the diseased portion, to ascertain whether the putrefaction has spread. Small sponges are usually totally destroyed when once attacked; in large ones, a limit may sometimes be set to the mischief.

The dissection is rapidly performed, either with an ordinary knife, or, as Buccich found, better with a fine saw-like blade, which is much less liable to injury by the foreign matters so abundantly found in sponge. The sponge is laid upon a smooth wooden board, moistened with sea-water. The size of the cuttings is usually about 26 c. mil. (1 cubic inch). It is well that each cutting should have the greatest possible area of uninjured outer skin. The cuttings are placed directly in the spots where they are intended to resume growth.

A healthy piece of sponge firmly attaches itself to any surface with which it comes into intimate contact in a short time. Cut sponges grow together again. The attachment takes place most rapidly when the pieces have but one cut surface, and this is laid upon the support—wood, stone, &c. During perfect calm, for at least 24 hours, it is possible, according to Buccich, to plant the cuttings upon the stony sea-bottom itself, and they will hold. He saw pieces that were merely cast into the sea on an ordinarily suitable rocky bottom, during perfect calm, attach themselves and grow. Thus enlightened as to the natural habits of the sponge, Buccich prepared stone slabs, 53 mm. (2 inches) thick, as a foundation. These he perforated with holes, and fastened the cuttings to them by wooden pegs driven into the holes; but it became evident that the mud and sand of the sea-bottom, perhaps also excess of light, were inimical to further growth, and the necessity for preventing or minimising these two evil influences has been shown by all experience. Preference will always attach to stone as a foundation, it being the natural ground, cheap, and not attacked by the teredo. Originally Prof. O. Schmidt employed perforated wooden chests, on whose inner side, the cuttings were fixed by means of metallic or wooden tacks. This extremely simple arrangement was found unsatisfactory, as the chests, when sunk in the sea, became filled with sand, and the holes got stopped up and ceased to admit light. The sponges acquired a white sickly look. The attaching of the cuttings by metallic pegs is objectionable; all cuttings thus treated were much slower to resume growth than those pegged with wood. The rust which soon forms on the metallic nails prevents the sponge from taking a firm hold, so that the immediate portion, and possibly the whole cutting, is ruined. Lattice frames, having the form of floating tables above, and with the sponges attached beneath, have also been tried. Professor O. Schmidt also suggested merely tying the cuttings to strong suitable strings. By the first plan, there was too much shade; by the second, too much light; and possibly some mischief was done by the fine matters drifted over the surface of the sea, and accumulated as a deposit of the compound vaguely known as "dirt." Buccich first constructed an apparatus composed of two planks crossing each other at right angles, with a third plank as a cover. This was so far successful that the cuttings were exposed on all sides to the action of the sea, and assumed the desirable round form. He then made a modification of this apparatus, consisting of two boards, 63 c.m. ($24\frac{1}{2}$ in.) long, and 40 c.m. ($15\frac{3}{4}$ in.) broad; one forms the bottom, and the other the lid, and they are held parallel one over the other at a distance of 42 c.m. ($16\frac{1}{2}$ in.) by two short stays, some 11 c.m. ($4\frac{1}{4}$ in.) apart. In the space between these stays, stones can be placed as ballast; on the top of the cover, is a handle. In both planks, holes are bored at 12 cm. ($4\frac{1}{2}$ in.) apart, or 24 holes in each. Buccich fastened the cuttings not simply on the apparatus, but on sticks which were driven into the holes of both boards. As material for the sticks, he chose before everything the common Spanish cane, whose siliceous rind is proof against the attacks of the pile-worm. The sticks were 42 c.m. ($16\frac{1}{2}$ in.) long, and bored through at distances of

12 c.m. ($4\frac{1}{2}$ in.), the lower end being split. On each stick, three sponge-cuttings were fastened in such a manner that they should lie over the bore-holes; through these, wooden sticks were thrust, and each cutting was thus fixed. [It is a matter of great regret that no illustration of these several apparatus was published in the original.]

When the sponge-cuttings are to be pegged only with wooden nails, a triangular stiletto will suffice for piercing the sponge. When adopting the method of fixing by sticks, such an instrument is not suitable, because much too great force would be required to make an opening to admit the sticks. Forcing and squeezing cause a loss of *sarcode*, the minimising of which is the first rule that governs all manipulations of sponge. Buccich bored the cuttings with an auger with toothed edges, 6 mm. ($\frac{1}{4}$-inch) broad, fixed to a vertical wheel, driven rapidly by a little pulley. While one hand quietly presses the sponge against the borer, the other turns the wheel. In a few seconds the operation is concluded. The bore-hole is clean, the fibres are not torn, and the *sarcode* does not run out. When a stick is filled with cuttings, its split end is thrust into one of the holes in the support, and a wedge is driven through the slit. As each bottom and top takes 24 sticks, carrying three cuttings apiece, one such apparatus will accommodate 144 cuttings.

During the whole manipulation, until the arranging of the sponges is quite complete, they must be repeatedly and gently moistened with sea-water, especially in summer. When an apparatus is furnished, it should be sunk at once in warm weather; in winter, as before remarked, a little delay does no harm. The apparatus may be most conveniently let down and pulled up by means of a small anchor. The depth may be 5 to 7 metres (16 to 22 ft.)

The suspension of the apparatus from a support, Buccich does not consider necessary. All woodwork must be well tarred. This is not a perfect remedy, but is the only temporary precaution available against the pile-worm. In the Bay of Socolizza, it was proved that the tarred portions even were destroyed at last. The teredo not only increases the amount of capital necessary for repairing the damaged apparatus, but also depreciates the condition of the cuttings, as the pegs or sticks fall out, and the sponges are destroyed. The most rational mode of procedure would therefore be to avoid wood altogether, and to make use either of stones, with suitable precautions against mud and direct light, or to employ iron in the construction of the apparatus recommended by Buccich.

If the cuttings hold fast after three or four weeks, the propagation is secure. A characteristic feature of the cuttings is their tendency to assume a round form. To facilitate this on every side, is the chief aim of Buccich's system of supporting on sticks. As to the rate of growth of the cuttings within a certain period, no rule can be given, on account of the varying conditions. Buccich remarked that the cuttings in the first year were two or three times as large as they were originally. He further remarked that the cuttings grew better in the first and fourth years, than in the second and third—a point evidently regarded as doubtful by Dr. Marenzeller; and it would seem that though some specimens may have attained a considerable size in the fifth year of transplantation, still a term of seven years is necessary to produce a marketable and profitable article. Dr. Marenzeller also mentions the fact that, besides being beautifully formed and rounded, the cuttings retain these qualities, and perfect health, with increasing size.

In conclusion, Buccich proposes the question whether the undertaking can be made profitable, and answers it in the affirmative. He is of opinion that, with due care in the operations, the cuttings will thrive, and the loss need never exceed 10 per cent., including all contingencies. Taking the cost of the establishment of 5,000 cuttings at about 300 gulden (the gulden is worth nominally 2s., really about 1s. 8d., or say 300 gulden = £25), and the loss at 10 per cent., there will be a crop of 4,500 sponges at the end of seven years, the value of which Buccich places at 900 gulden. Dr. Marenzeller considers this price far too high, as the wholesale merchants in Trieste give an average of 8 gulden, and a maximum of 10 gulden per kilo. of Dalmatian sponge. The sponges must be of considerable size, such as will not with certainty be attained even in seven years. Finally, allowance must be made for the fact that the sponges grown on sticks are considered commercially inferior, and that their value, on account of the central perforation, is one third less than that of naturally grown sponges. The profit would seem larger if there were not so long an interval between the outlay and the harvest; in other words, if the growth of the cuttings were not so slow. A seven years' suspense is a great deterrent. To this must be added, that in order to maintain a continual production during the seven years from the commencement, an annual outlay, equal to the first, is necessary, while the apparatus is not so simple that any dweller on the coast can make it for himself, and wood is not available, by reason of the pile-worm. Dr. Marenzeller, therefore, concludes that the propagation of sponge by cuttings is not to be recommended to people without capital, but is more suited to the attention of a capitalist, or an association of capitalists, and to be conducted on a large scale. [The great absence of money in Austro-Hungary must be borne in mind in weighing this opinion.] It would be a matter of great encouragement did we possess the knowledge how to augment the growth of sponge under natural conditions, even though it were no more rapid than in the case of the cuttings. This being so, Dr. Marenzeller considers it more than questionable whether it would be advantageous to cut into pieces a sponge which, uncut, would have more quickly reached the same size and weight as the collective cuttings, and attention might then be restricted to the production of properly rounded, even though small, sponges from ill-shaped and commercially worthless ones. Possibly, also, the production of more individuals of larger size and better form might be effected, which, according to Cavolini's experiments, and in Buccich's opinion, should present no difficulty.

BRITISH MUSEUM PRINTED CATALOGUE OF PRINTED BOOKS.

Another important step has been taken by the Trustees of the British Museum in the gigantic task of turning the voluminous MS. catalogue into a printed one. The MS. catalogue already takes up more room in the Reading-room than can well be spared, and it is calculated that when all the MS. entries are superseded by printed ones that the volumes will be reduced in number to about a third of what they are at present. Some of the volumes are now congested with entries, and it has therefore been decided to print these crowded entries in the first instance. In order to carry this decision into effect, the first portion of the letter B has been printed, and it forms a folio part of 191 pages. The first entry is as follows:—

"B *see* A. The Lord's-day, the Sabbath day. . . Digested dialogue-wise between two Divines A and B, &c., 1636 4to. 4355. b."

The last entry is—

"B. y S., D F. Florinda, escena tragica impersonal [in verse] Por D. F. B. y S. Valencia 1816 4to. 1342, f. 1 (37)."

It is not intended to continue the printing in any particular order, but to deal first with those portions of the catalogue that require re-arrangement on account of the crowded nature of the MS. entries. It is therefore

not probable that the letter B will be completed at the present time.

This printing of the old slips will not effect the progress of the catalogue of modern books and new additions which will be continued independently.

MANUFACTURE OF MATTING IN CHINA.

The United States Consul at Canton reports that the manufacture of matting is extensively carried on in China, especially towards the south, where it is one of the most important industries engaged in. Enormous quantities of matting are made both for export and also for home use, much being used as sails on the native sailing craft, as it is much cheaper, if not more durable, than the ordinary canvas or sailcloth. It is also used as coverings for boxes and packages in which tea, sugar, cassia, &c., are exported; also in making money bags, it being a very convenient mode of handling dollars, especially when broken up into small pieces by the constant stamping or "chopping" of the dollars, as is the custom in China. The plant from which the mat sails, &c., so extensively used in China, is obtained, is known as "aquatic grass," also as "rush." It is cultivated in the Shuihing department on the West River, about seventy-five miles in the interior from Canton. It is grown in the same way as rice, in fields flooded with water. It requires very little care in its cultivation, as it propagates itself by shoots from the root, and attains a height of from six to eight feet. It is brought to market in bundles of about twelve inches in diameter, and if of proper length and good quality, sells at about 10d. per bundle, each bundle being sufficient to make four bed mats, or six such as are used for making sails. The district of Tung Kuan produces large quantities of this grass, but of a species used almost entirely in the manufacture of floor matting. It is said to grow better in the vicinity of salt water, where the water flooding it is somewhat brackish. It is planted usually in the month of June from slips. These are allowed to grow for about two months, when they are replanted in rows. The soil being plentifully manured with bean cake, it requires nearly twelve months to mature, when it is cut, the shoots or straws are split in two with a knife, and, when partially dried in the sun, packed in bundles, and manufactured into matting at the city of Tung Kuan, or brought to Canton, where there are several extensive manufactories. When brought to the factory, the grass is carefully sorted, it is then made into bundles of two or three inches in diameter, and placed in large earthenware jars, holding about ten gallons of water; it is allowed to remain thus in soak for three days, when it is taken out and dried in the sun for a day. If it is to be dyed the ordinary red colour, which has been for years much in vogue, it is placed in jars containing a liquid dye, made by soaking red sapan wood chips in water. It remains in these jars for five days, then dried for a day, afterwards again immersed in the dye for three days, when it is usually ready for use. It is only within the past two or three years that other colours, such as green, yellow, and blue, have been used to any extent. The solution for colouring yellow is produced from the seeds and flowers of a plant common to China, the "hui fà." A yellow colouring matter is also made by boiling, for several hours, twenty-five pounds of *Sophora Japonica* in one hundred gallons of water, and adding, when cooled, one pound of alum to each ten gallons of the solution. Green and blue are produced from the twigs and leaves of the "lamyip" or blue plant, which grows in abundance near Canton. To the solution thus produced a small quantity of chemical dye is now usually added. In dyeing these colours, the straw is soaked in water for seven days, and then immersed in the colouring matter for a few hours only, the solution being hot. Consul Lincoln states that in a recent visit to one of the largest manufactories, he found fifty looms being worked, eight of which were large, and forty-two small. The large ones are exactly the same as the ordinary silk loom, and are used in making the very wide, and also the damask or carpet patterns. Three men are required to work each of the large looms, their wages being from 1s. 3d. to 1s. 8d. a day. Eight yards of matting from each loom is considered an average result of a day's work. The small looms are rude and simple, each being worked by two small boys, who are paid from 7d. to 10d. per day each, and who daily weave five yards of most perfect matting of the more ordinary patterns. The loom is composed of two uprights, driven into the ground, about five feet apart, and about four feet in height, two cross-bars fit into sockets in the uprights, one at the top, the other about eight inches from the ground. The warps, which are strings of Chinese hemp, two yards and a-half in length, are then passed over the upper, and round beneath the lower cross-bar, through the holes in the weaving bar, and, being drawn taut, are fastened by both ends to a long, thin piece of bamboo, placed parallel with, and just below the lower cross-bar. The weaving bar, and the most important part of the loom, consists of a piece of wood, varying in length according to the width of the matting required, and about two inches square; through this, small holes are pierced at different intervals, into which the warps are passed; the bar can thus be worked up and down in the warps by means of handles near the extremities—these holes vary in distance from each other according to the pattern desired—alternately on top and bottom. The holes are enlarged, or formed into slots, converging at the centre of the stick. When the warps have been thus arranged, and bundles of different coloured straw, sufficiently damp, deposited near the loom, one of the boys raises the weaving bar to the top of the warps, tipping it forward, the slits in the bar allowing the alternate warps to remain perpendicular, the holes carrying the others forward, thus separating them sufficiently to admit of a single straw being passed between them. This is done by a long flat piece of bamboo, a notch being cut near the end, into which one end of the straw is placed, and then used as a shuttle. When the bamboo is withdrawn, the weaving bar descends, carrying the straw to the bottom; the bar is then raised again and tipped down, thus carrying the warps backward which had just before been passed forward, the work of the shuttle being repeated. As the weaving bar presses the straw down, the weaver gives the ends of the straw a half-turn round the outside warps, the operation being repeated until the warps are full, the edges trimmed, the warps untied, the matting now two yards in length removed, and a new set of warps put on. The matting thus woven is then dried in the sun, and over a slow fire. The shrinkage consequent on this drying is nearly four yards in forty. When dried it is stretched on a frame and worked down tight by hand, then sent to the packing-house, where men are engaged in fastening the two yards lengths together, it requiring twenty lengths to make the ordinary roll. The fastening together is done by taking the projecting ends of the warps of one piece, and by means of a large bamboo needle, passing them backwards and forwards through the reeds of another piece, in fact, sewing them together; each roll of forty yards is then carefully covered with a coarse, plain, straw mat, marked and numbered ready for shipment.

OOLACHAN OIL A SUBSTITUTE FOR COD LIVER OIL.

Under the above name a new medicinal oil has lately been introduced to English commerce. It is said to so closely resemble cod liver oil, both in appearance and

therapeutic ffect, as to be scarcely distinguishable from it. This new oil is obtained from a fish which is found on the coast of Vancouver's Island and British Columbia, as well as in the bays between the Frazer and Skena rivers. It is known to the North American Indians as the Oolachan or Candle fish, this latter name being derived from the fact that, in a dried state, it is used by the natives as a torch or candle, on account of the large quantity of oleaginous matter it contains. The fish is described as being about the size of a herring, and in habit similar to that of the salmon; ascending the river once a year to spawn, it remains only for a very short period, sometimes not more than a day, and, as it can be caught only at these times, the manufacture of the oil is somewhat precarious.

As a food the fish is highly valued by the Indians, by reason of the delicacy of its flavour, and it is also esteemed by them for its medicinal virtues. As a medicinal the oil has already established a reputation in America as a valuable substitute for cod liver oil, and it is believed that when it becomes better known in this country it will take a high position with us.

GENERAL NOTES.

Paper Belting.—It is reported in *Engineering* that paper belting is successfully used in the machinery-hall of an exhibition now being held in Japan. The Japanese have long been celebrated for their manufacture of some exceedingly tough descriptions of paper, and it is stated that the paper belting has been tested and found much stronger than ordinary leather. Now that machinery is rapidly making its way into Japan, the manufacture of this paper belting is of special interest to the country, as from the want of proper tanning good leather is not made by the Japanese.

A New Gum.—Mr. Thomas Christy, F.L.S., of Malvern-house, Sydenham, writes:—"I have received a case of gum, or resin, which is treated after being taken from the *Pistacia terebinthus* tree, and by boiling, the gum is extracted from the resin. This resinous substance is employed in more than one way in the East, viz., for glazing printed calicoes, and in some preparations it renders the cloth waterproof. It is also used in bookbinding, and for sticking paper together, as water has no effect upon it. I shall be very glad to distribute samples to those who care to try experiments with it, if they will promise me their results."

Glass Sellers' Company.—The Court of the Worshipful Company of Glass Sellers, have given notice that they are prepared to award a sum not exceeding £110 in prizes, for essays on the "Past and Present Position of the Glass Trade," as follows:—£50 for an essay on the "Glass Trade in all its Branches;" £20 for an essay on the "Trade in Crown, Sheet, Plate, Rolled, and Cathedral Glass;" £20 for an essay on "Flint and Pressed Glass;" and £20 for an essay on "Bottle Glass." Competitors will be expected to consider the present state of the trade, as compared with its condition in foreign countries. The Court, however, are not desirous of inducing the writers to prepare historical notices of the trade, and they would prefer that the writers should deal with historical matters only, so far as they bear upon the present state of the British glass trade. The essays must be sent in not later than the 31st January next, to the Honorary Clerk, at the office, 58, Gracechurch-street, E.C., from whom further particulars can be obtained.

MEETINGS OF THE SOCIETY.

Foreign and Colonial Section.

Tuesday evenings, at eight o'clock:—

May 31.—"The Principality of Loo Choo." By Consul John A. Gubbins. Sir Harry Parkes, K.C.B., H.B.M.'s Minister in Japan, will preside.

Cantor Lectures.

Monday evenings, at eight o'clock:—

The Fifth Course is on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter, F.R.C.S. Three Lectures.

Lecture III.—Monday, May 30.

Industries chiefly affected by colour blindness—Engine-drivers, pilots, artists, letter-sorters, drapers, painters, &c., &c. Recent legislation affecting colour blindness in America, and urgent need for it in this country. Conclusion.

MEETINGS FOR THE ENSUING WEEK.

Monday, May 30th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. R. Brudenell Carter, "Colour Blindness, and its Influence upon Various Industries." (Lecture III.)
Institute of Surveyors, 12, Great George-street, S.W., 3 p.m. Annual General Meeting.
Asiatic, 22, Albemarle-street, W., 4 p.m. Annual Meeting.

Tuesday, May 31st...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Foreign and Colonial Section.) Consul G. A. Gubbins, "The Principality of Loo Choo."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Dewar, "The Non-Metallic Elements." (Lecture VI.)
Central Chamber of Commerce (at the House of the Society of Arts), 11 a.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Richard Henry Brunton, "The Production of Paraffin and Paraffin Oil."

Wednesday, June 1st...National Health Society (at the House of the Society of Arts), 7.30 p.m. Mr. S. Stevens Hellyer, "The Science and Art of Sanitary Plumbing." (Lecture II.) Joints and Pipe Bending.
Entomological, 11, Chandos-street, W., 7 p.m.
Public Analysts, Burlington-house, W., 8 p.m. Special General Meeting for the consideration of the Scale for the Valuation of Impurities in Drinking Waters, which has been in partial use by some of the Members of the Society who are co-operating in the scheme of Water analyses. The subject will be introduced by a paper by Mr. Wigner.
Archæological Association, 32, Sackville-street, W., 8 p.m. 1. Mr. H. Syer Cuming, "Mermaids." 2. Rev. S. M. Mayhew, "Articles found in London."
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

Thursday, June 2nd ... **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8.30 p.m. *Conversazione* at the South Kensington Museum.
Antiquaries, Burlington-house, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. Sir John Lubbock, "The Habits of Ants" (viii.). Mr. S. O. Ridley, "The genus *Plocamia*, Schmidt, and on some other Sponges of the order Echinonemata." 3. Prof. Duncan, "*Diropalum*, a new genus of Spongida."
Chemical, Burlington-house, W., 8 p.m. 1. Messrs. A. H. Allen and W. Thomson, "The Saponification of Fatty Oils and Waxes." 2. Mr. Spencer Pickering, "The Sulphides of Copper, and a Determination of their Molecular Weight."
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Musical Lecture, by Mr. Alfred Gilbert.
South London Photographic (at the House of the Society of Arts), 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Paramagnetism and Diamagnetism." (Lecture VI.)
Royal Society Club, Willis's-rooms, St. James's, S.W., 6 p.m.
Archæological Institution, 16, Burlington-street, W., 4 p.m.

Friday, June 3rd...National Health Society (at the House of the Society of Arts), 7½ p.m. Mr. S. Stevens Hellyer, "The Science and Art of Sanitary Plumbing." (Repetition of Lecture I.)
Royal United Service Institution, Whitehall-yard, 3 p.m. Captain J. R. Lumley, "Mounted Infantry."
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. W. G. Adams, "Magnetic Disturbance—Auroræ and Earth Currents."
Geologists' Association, University College, W.C., 8 p.m.
Philological, University College, W.C., 8 p.m. Mr. H. Swift, "Some Points in English Grammar."

Saturday, June 4th...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. Poynting, "The Change of State from Solid to Liquid." 2. Mr. C. J. Woodward, "Illustrations of Fresnel's Theory."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. E. Turner, "Russian Literature." (Lecture III.) Gogol.
Institute of Actuaries, The Quadrangle, King's College, W.C., 3 p.m. Annual Meeting.

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FRIDAY, JUNE 3, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CANTOR LECTURES.

The third and concluding lecture of the fifth Course on "Colour Blindness, and its Influences upon Various Industries," was delivered by R. Brudenell Carter, F.R.C.S., on Monday, 30th ult. Attention was drawn to the industries chiefly affected by colour blindness, and the dangers and inconveniences consequent on the defect in the case of engine-drivers, pilots, artists, letter sorters, drapers, painters, &c. The lecturer alluded to the recent legislation in the United States, and pointed out the urgent need for legislation in this country.

The Chairman (Dr. Mann, F.R.C.S.), in moving a cordial vote of thanks to Mr. Brudenell Carter for his interesting and instructive course of lectures, drew attention to the curious fact that this most important defect of the human eye—one fraught with the most serious dangers—should only have been discovered within a comparative recent period. He thought, in listening to these lectures, of the remark of Helmholtz, that among the remarkable scientific discoveries of the present age, those which related to the domain of physiology were, perhaps, the most remarkable.

The lectures will be printed in the *Journal* during the autumn recess.

MEMORIAL TABLETS.

During the past month new tablets have been erected on six houses to commemorate the residence in them of the following celebrated men :—

James Barry—36, Castle-street, Oxford-street.
William Hogarth—30, Leicester-square.
[This house has been rebuilt for Archbishop Tenison's School.]
Sir Isaac Newton—35, St. Martin's-street.
Peter the Great—15, Buckingham-street, Strand.
Richard Brinsley Sheridan—14, Savile-row.
Sir Robert Walpole—5, Arlington-street.

The following is a list of tablets previously erected by the Society of Arts :—

Burke—37, Gerrard-street, Soho.
Byron—16, Holles-street, Cavendish-square.
Canning—37, Conduit-street.
Dryden—43, Gerrard-street.
Faraday—2, Blandford-street, Portman-square.
Flaxman—7, Buckingham-street, Fitzroy-square.
Franklin—7, Craven-street.
Garrick—5, Adelphi-terrace.
Handel—25, Brook-street.
Johnson—17, Gough-square, Fleet-street.
Napoleon III.—3A, King-street, St. James's.
Nelson—147, New Bond-street.
Reynolds—47, Leicester-square.
Mrs. Siddons—27, Upper Baker-street.

DOMESTIC ECONOMY CONGRESS.

Her Royal Highness the Princess Christian, President of the Congress, took the chair at the meeting of the Ladies' General Committee, held on Wednesday, 1st inst., in the Great Room of the Society of Arts. The following ladies attended :—The Countess of Airlie, the Countess Spencer, Lady Arthur Russell, Viscountess Strangford, Lady Marion Alford, Lady Jane Stewart, Lady Charlotte Schreiber, Lady Reay, Dowager Lady Stanley of Alderley, Lady Knightley, Lady Cole, Lady Clive Bayley, Lady Hogg, Mrs. Bartley, Mrs. Burke, Mrs. Russel Carew, Mrs. Charles, Mrs. Cotton, Mrs. Dacre Craven, Mrs. Cromwell, Mrs. Fowke, Mrs. Grenfell, Mrs. Hollond, Mrs. Lecky, Mrs. Mann, Mrs. Fenwick Miller, Mrs. Peploe, Mrs. Price, Mrs. Priestley, Mrs. Seeley, Mrs. Stansfeld, Mrs. Tubbs, Mrs. Webster, Miss Rose Adams, Miss Andrews, Miss E. Barnett, Miss Cole, Miss Gurney, Miss Hamonds, Miss M. Hooper, Miss Fay Lankester, Miss H. Martin, and Miss Stanley. Sir Henry Cole, Lord Alfred S. Churchill, and the Rev. Newton Price, members of the Executive Committee, were also present.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Dr. Hullah, the Society's Examiner, at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 4th July, 1881.

The examination of each candidate will be private; no one but the Examiner and the accompanyist being present, unless it be a member of the Society of Arts' Committee.

No list of Candidates will be published.

Full particulars can be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

FOREIGN AND COLONIAL SECTION.

Tuesday, May 31, 1881; Sir Harry Parkes, K.C.B., H.B.M.'s Minister in Japan, in the chair.

The Chairman, in calling upon the Secretary of the Section to read the paper, said he regretted that Mr. Gubbins was not present to read the paper, being obliged to absent himself through ill-health—the same cause which had brought him home to England for medical aid. The position of this little kingdom in the Pacific was very curious, on account not only of its antiquity and of its advances in civilisation, but also of the very peaceable and excellent disposition of its inhabitants. We, in England, had little acquaintance with these islands, as they lay rather out of the ordinary routes of commerce, but Englishmen had landed there occasionally for more than sixty years; and whenever a foreigner had done this, he had been struck by the cordial reception he met with. About four years ago he (the Chairman) had occasion to visit the islands, and one of the first things he was shown was the grave of a seaman belonging to his Majesty's ship *Alceste*, who was buried there in 1816. The tomb was kept up with great care, and the inscription was almost as legible as the day it was cut. Of course he expressed his gratitude for the care which had been bestowed on the grave of a fellow countryman. Although this little State had had its own autonomy for many centuries, it had lately been the subject of a political question between the empires of China and Japan, to both of which it had been accustomed to pay tribute. This could hardly be expected to continue indefinitely, and Japan had lately made special claims, and annexed the whole islands, so that Loochoo had, in fact, now ceased to exist as an independent principality.

The paper read was—

NOTES REGARDING THE PRINCIPALITY OF LOOCHOO.

By John A. Gubbins, of the Consular Service.

A common mistake made by foreigners in China and Japan is to suppose that the principality of Loochoo—which, for several centuries, has existed as a tributary State, owing allegiance both to China and Japan, but at the same time governed by her own laws, and having her own peculiar manners and customs—includes the whole of those islands known to navigators as the Loochoo group. The northern islands of this group, however, of which the principal are Oho-sima, Yarabu-sima, and Kikai-sima, have been Japanese possessions for nearly three hundred years, and at a comparatively recent date another small island was added to the list.

Loochoo proper consists of the large island of Okinawa-sima, and nine outlying groups. There are besides smaller islands, more or less distant, which are too numerous to mention in detail.

According to statistics obtained on the spot, the total population of Loochoo in 1875 was 165,930, divided as follows: — Main island — Shizoku, 29,633 men; 29,722 women. Heimin, 28,980 men; 28,981 women; total, 117,316. Other islands of which the Miyako group contibutes a half, 52,495, the proportion of women being slightly in excess of the men.

The population of the main island is very unequally distributed, more than half of whole number of inhabitants being included in the four towns, which are also distinguished from the rest of the country by the fact that the population is composed almost entirely of Shizoku. The island of Okinawa has three large geographical divisions, which are subdivided into thirty-five Magiré,* or districts, that are again divided into mura, or villages.

Class Distinctions and Nobility.

The people of Loochoo may be roughly divided into two classes—Shizoku and Heimin—a distinction borrowed from Japan. The king, is of course, the head of the State. Next to him in rank come:—1. Nobles of the first rank and first grade. This class comprises the uncles, brothers, and sons of the king, who have the title of Oji. 2. Nobles of the first rank and second grade. This class comprises all the other relations of the king, who have the title of Andzu. The rest of the nobility then follow in the order given below: —Second rank, first and second grades, Oyakata (the "Sandzukwan," or Thruknia Oyakata, by virtue of their position take rank with the Andzu). Third rank, first grade to sixth rank, second grade, Paikin. Seventh rank, first grade, Satonoshi Paikin. Seventh rank, second grade, Chikudon Paikin. Eighth rank, first grade, Satonoshi. Eighth rank, second grade, Wakazatonoshi. Ninth rank, first grade, Chikudon. Ninth rank, second grade, Chikudon Zashiki. No rank or grade, Zashiki. These titles are quite independent of official designations; they are not necessarily hereditary, and are conferred on individuals for services rendered to the State.

Government Departments and Officials.

The King of Loochoo is nominally at the head of the Government, but his share in the actual administration is very small. All affairs of State are carried on by officials chosen from among the nobility, at the head of whom is the Sessei or Prime Minister, who is selected from the Princes of the blood, or, failing such, from the King's relatives. It may, indeed, be said that the Sessei, who presides over the Council of State, and the Sandzukwan divide the heaviest responsibilities of Government between them.

Some idea of the system of Government may be gathered from the following list of public departments and the officials attached to them:—

Hiôjô-sho, or Council of State, which has the superintendence of all important business, and alone has power to decide matters of State. To this are attached the Prime Minister and the Sandzukwan (who are not chosen by the King, but by the general vote of the leading officials and nobles). The rest of the staff is made up of one Head Secretary and six Under Secretaries. One of the Sandzukwan has charge of the Salary Department, and the control of matters connected with mountains; another has charge of the

* This term is evidently taken from an old land division in Satsuma, called Magiri.

Emergency Department, and the control of matters connected with rivers. These two serve alternately for one month at a time. The third has charge of the Finance Office, and the control of districts and islands.

Monobugiôsho, or Home and Finance Department, with three sub-departments, viz. (1) Finance Office, with control over receipts and expenditure connected with the productions of various districts and islands; (2.) Salary Office; (3.) Office where cases of emergency, such as landslips, inundations, &c., are dealt with.

Moshikuehi-ho, or Foreign Office. The duties of this office are—(1.) Conduct of relations with foreign powers; (2.) Distribution of rewards and punishments.

Hiraho, or Judicial Department, with a staff of one judge, Hirato-to-soba, and two Gimi. Sho-in-ho, or Department of Ceremonies; Kin-jiu-ho, or Royal Household; Kei-dzu-za, or Herald's Office; Tai-yo-za, or Registrar's Office; Jisha-za, or Board of Religion; Yobutsu-za, or Chinese Tribute Department; Tachi-ho, or Board of Agriculture; Yamabugiô-sho, or Department of Woods and Forests; Fushinbugiö-sho, or Public Works Department; Shi-josé-za, Office for Control of Japanese Tribute, and other business connected with Japan.

These are the principal Government Departments. It would be too tedious to go through the whole list of minor offices. The most trivial affairs appear to have separate offices for their control. Among others are—the O-dai dokoro, or Royal Kitchen; the Rionza, or office for superintending the preparation of food for banquets given to Chinese delegates and other foreign envoys resident in Loochoo for the time being; the Kin-yaku, or Government stables; the So-yo-komi-sho, or Board for supervision of the manners and customs of the people; and the Kawara-bugiô-sho, or office for controlling the manufacture of tiles for the roofs of houses.

Again, the duty of collecting the revenue, and the control of receipts and expenditure, are divided amongst six or seven different departments. Besides the above-mentioned offices, each district has a Bansho, or local office, and to each of these are attached one Jito, or lord of the manor, one Wakijito, one Shiuri-Yako, one Osabakuri, one Hayésabakuri, and several Sabakuri, the number of whom is not fixed. The first three are appointed from Shiuri, and are not natives of the district. The other offices are filled by local men. The officers who administer the islands of Miyako and Yayeyama are—one Zaiban, or Governor, three Chau, from three to five Oyako, and several subordinate officials.

As in the case of the districts, the officers below the grade of Oyako are local men. There are also officials called Yénin, detached for foreign sevice in Japan.

At Kagoshima there has been a Loochooan Yashiki ever since the conquest of Loochoo by Satsuma in 1610, and Oyakata and other leading men used to reside in it. Since 1868, however, the Yashiki has been called the Kura-Yashiki, and officials of the Home and Finance Department have resided for a term of one year at a time, their business being to superintend the purchase of goods for the Han. Although in the time when tribute was paid to China, a resident interpreter was attached to the Loochooan factory at Foochow, there was never a regular foreign service similar to that adopted in the case of Japan.

The laws of Loochoo include, in addition to a Civil and Penal Code, a complete set of regulations concerning the distribution of rewards. One or two instances will suffice to illustrate the character of these rules:—

Rewards (including increase of rank, official appointments, and presents of goods) are given to persons who promote the interests of agriculture in various ways, which are detailed; who have made themselves conspicuous by deeds of charity and benevolence; who give assistance in cases of famine and shipwreck; who attain the age of 100 years; to officials who lessen official expenditure; who improve the Government finances by inaugurating reforms of various kinds; to women who show great respect to their husband's parents; and to widows who remain single.

With regard to the Civil Code I have been unable to gain any information.

The Penal Code of Loochoo is based on the laws of China, and the ancient laws of Satsuma. It is remarkable for its simplicity and severity, and the influence of Confucianism may be clearly traced. I understand, however, that the penalties laid down were by no means strictly enforced. By order of the Japanese Government the Loochooan criminal code was lately abolished, and Japanese criminal law has taken its place. Still, in spite of the fact that these laws have ceased to exist, the following short notice of them may not be without interest.

Offences in respect to parents, ancestors and relations, ranging from murder down to simple assault, were punished with crucifixion, decapitation, or banishment, according to the gravity of the crime. The murder of a husband by his wife, was punished with crucifixion. Murder in other cases, forging the Government seals, opening or rifling graves, burglary, accompanied by manslaughter, and other personal violence, with decapitation. Bribery, libel, the profession of Christianity or other religion not recognised in Loochoo, adultery, theft of official money, entering the castle without permission, and gambling (second offence), were punished by banishment—in some cases to uninhabited islands.

Violence offered to people by persons under the influence of drink was punished—In the case of Shizoku, by confinement in temple buildings; in the case of Heimin, by flogging and imprisonment; in the case of officials, by dismissal. Taking a man's wife and children in pledge for money lent was a punishable offence, but did not come under the head of grave crimes. Those also who charged a higher rate of interest on money lent than 20 per cent. per annum were punished. Two things are brought out very clearly by these laws—namely the subordination of a wife to her husband, and of the Heimin to the Shizoku.

Revenue and Expenditure.

On this subject I obtained the following information from the Home Office Secretary, resident at Nafwa. The yearly assessment of cultivated lands in Loochoo, is fixed at 94,233 koku of rice, of which 75,134 koku are contributed by the

main islands, and of balance by the adjacent islands in the jurisdiction of the Han.

The taxes in Loochoo may be divided into two kinds—seizei, or regular taxes, and zatsuzei, or miscellaneous taxes. The seizei, or regular taxes, form the revenue of the Government, and consist of rice, 21,580 koku; sugar, 2,048,239 koku (probably catties); other cereals, 5,379 koku; millet, 4,877 koku; cash, 2,705,768 kwan = yen 48,115$\frac{7.3}{4}$. As against this, the Government expenditure is as follows:—Tribute paid to Japan, 11,122 koku of rice. Office expenditure —Rice, 5,171 koku; other cereals, 4,066 koku; cash, 31,187,720 kwan = yen 623,754$\frac{6.0}{4}$. Expenditure of King—Rice, 1,046; incomes of Han retainers—Rice, 2,867 koku. Officials' salaries—Rice, 3,113 koku; other cereals, 2,027; cash, 285,563 kwan = yen 5,711$\frac{2.6}{4}$. The miscellaneous taxes (zatsuzei) are local taxes paid by the people of the various villages and districts to the lords of the manor (jito and wakijito). With regard to these Mr. Kinashi, the resident secretary of the Home Office, informed me that in spite of repeated efforts, he had found it impossible to obtain reliable statistics on the subject. These taxes, it appears, are not fixed, but vary in each village, according to the quality of the soil, and the number of inhabitants, and the amount to be collected is left very much to the discretion of the local lord of the manor. Charcoal and firewood are included under the head of this indirect taxation, and I ascertained that it is in the power of the jito to levy the taxes due to him in any form which suits him. Thus, if he wishes to lay in a stock of fuel for the winter, he may demand to be supplied with charcoal and firewood to the amount necessary for his use, and, instead of paying for it at the time, he may subtract the value of the supplies furnished from other taxes due to him. He may also employ labour to any extent which he may think fit, the wages of the people employed serving as a set-off against the taxes to be collected from them. It is obvious that under such a system as this the greatest injustice can be committed. To a man who earns his hiring from day to day, it is the greatest hardship to be taken from his daily employment, and be compelled to do work, the payment of which is deferred to an indefinite period. In such a position the labourer becomes little better than a slave.

Productions of Loochoo.

According to a table of statistics (which is compiled from native sources), kindly furnished to me by the Japanese Home Office authorities at Nafwa, the value of the total exports from Loochoo to Japan during the year amounts to* yen 241,300, as against imports to the extent of yen 121,800, leaving a balance in favour of the islands of yen 119,500.

Imports.—The imports from Kagoshima, which serves as the port of connection between Japan and Loochoo, are:—

	Yen.
Rice	30,000
Beans	3,400
Rapeseed Oil	5,000
Tea	1,200
Lacquer	1,200
Tobacco	4,000
Vermicelli	9,500
Raw cotton	8,400
Thread (cotton)	26,600
Miscellaneous, including dried fish, saké, seaweed, hair-oil, timber, iron, iron-ware, hardware, and foreign goods (about)	16,900
Total	Yen 121,800

The above figures do not include some minor items, the returns for which have not been obtained; and in the case of each item, it must be borne in mind that the figures represent only the approximate annual amount.

Exports (principally to Kagoshima).—Sugar figures, of course, as the chief item, the average yearly export of this article being 6,500,000 catties, representing an approximate value of yen 162,500, or more than two-thirds of the total value of the exports.

Statistics are wanting in the case of the other articles, but they may be roughly estimated as follows:—

	Yen.
Cotton cloth	28,000
Hempen cloth	12,500
Other cloth	7,200
Tenmugi (silk fabric)	2,800
Yellow dye (ukon)	900
Loochooan saké (awamori)	2,500
Medicinal drugs	2,700
Salted pork	2,300
Umbrellas	950
Rope	650
Miscellaneous	18,300
	78,800
Add sugar	162,500
Total	Yen 241,300

The exports above mentioned naturally afford an indication of the principal productions of the country. But there are other productions, which, for obvious reasons, do not figure in the list of exported goods. Under this head come

Potatoes.—Which may be regarded as the staple food of the islands.

Rice.—Which gives two crops, one grown in the spring and one in the autumn, yielding some 32,000 koku.

Indigo.—Used everywhere as a dye, and grown by individuals for private use.

Peas and Beans.—Both Japanese and foreign varieties, the latter having been introduced within the last 60 years. Capt. Hall, in his "Voyage and Journal," speaks of having given the seeds of various English vegetables to the Loochooans, and adds that they were instructed how to grow them. The date of his visit, in H.M.'s *Lyra*, to the Loochooans—1816—corresponds with the date of their introduction as mentioned to me by the natives.

Millet.—

Palms.—Which are grown extensively under the superintendence of the Government, in order to

* In the case of exports, the exchange between Loochooan and Japanese currency is taken at 50 kwan to the yen, this being the rate ruling at the Port of Nafwa. In the case of imports, the Kagoshima rate of exchange, 32 kwan to the yen, has been adopted. If the same rate be taken for the imports as for the exports, the total value of the former will reach yen 140,000, thus greatly reducing the balance in favour of the islands.

serve as a resource in times of famine, the heart of the root being eaten.

Coral.—

Cattle.—(Horses, bullocks, pigs, and goats). Every farmer is obliged to keep three or four pigs or goats for the sake of the manure which is thus derived; should he fail to do so, a money payment is exacted.

Sugar.—This production, to the growth of which these islands owe whatever commercial importance they possess, is stated to have been introduced into Loochoo from China in the year A.D. 1623. At present it forms by far the most important product of the islands. I was unable to procure statistics of the average yield of the year, although, judging from the number of Government offices which are concerned in the cultivation of sugar, and in its collection as a portion of the revenue, the most accurate information in this respect ought to be obtainable. In former years the trade in sugar with the Loochoos was in the hands of the Satsuma Han, and it is doubtless in part owing to the existence of this lucrative monopoly that Han attained such a flourishing condition. The sugar used to be conveyed to Kagoshima, from the Loochoos (a large proportion—that coming from Oho-sima and Yarabusima—being actually the property of the Han), and thence it was sent by Japanese junk to Osaka, where it was sold in large lots by the Satsuma agents at the Yashiki of the clan to the highest bidders by written tender. The merchants who purchased it then retailed it to smaller dealers, and it was in this way gradually distributed to different parts of the country. It is estimated that the value of the sugar which used to pass through the hands of the Satsuma authorities was not less than yen 500,000. This estimate, however, judging by the present export of sugar from Loochoo proper, seems to be rather large. Of late years, since the abolition of the Han, the sugar has been bought by private merchants and trading companies at Kagoshima and Osaka, and no control over the trade is exercised by the Government.

The sugar plantations are owned by private landowners, the proprietorship not being restricted to any class. Each proprietor has his own sugar mills conveniently near to the plantations. These mills are of very primitive construction. Imagine a circular space some 30 feet in diameter. In the centre of this are three cylindrical rollers arranged vertically side by side. The centre roller is higher than the two others, and is turned by means of a long pole, fastened to the top of the roller, and to the neck of a pony or bullock, who moves along a circular path on the outer edge of the enclosure. By means of simple cogs, made so as to fit one into another, the centre roller turns the two others. The mill is fed by two men, who sit one on each side, and each cane is crushed twice, being passed through between the centre and the right hand only to be passed back again between the centre roller and the roller on the left. The juice, as it is expressed, falls into a trough underneath the rollers. Through this it runs into a tub, which, when full, is emptied into the ovens close by.

The ovens are round, open at the top, and built of earth. Each is protected from rain and wind by a thatched roof, which also affords shelter to the men who attend to the fire. The process of boiling the sugar is simple enough. Before lighting the furnace below, three shallow iron pans are arranged in the oven, in the form of a trefoil, and the spaces between them and round the side of the oven are built up with a mixture of clay and straw. The liquid sugar is then poured into the pans, and, the furnace being lighted, is allowed to boil five or six hours. During this operation, the burnt ash of a stone collected on the sea-shore, is mixed with it in definite proportions. When the sugar is sufficiently boiled, the pans are removed, and placed in the open air. Here the sugar is stirred until it becomes cool, and it is then poured into tubs, where it forms a solid cake. Each tub holds about 120 catties. Sugar is conveyed by coolies from the plantations to Nafwa, whence it is exported to Japan. The boiling season is during the cold weather, from November to February.

Foreign Intercourse.—Relations of Loochoo with Japan, China, and other Foreign Powers.

The ancient history of Loochoo is enveloped in mystery, and its earliest historical traditions bear a resemblance to those of its larger neighbour, Japan. Considering that the first native history of Loochoo, the "Chinzan Sekan," was not compiled till the year A.D. 1650, the legendary character of these traditions is no matter for surprise; but the claim upon our credence passes all reasonable bounds.

We are asked to believe that the dynasty, of which the first ruler was a mythical personage known to posterity as Tensonji, existed for a period of 17,800 years, ending in A.D. 1190. In the latter year, a new dynasty was founded, according to Japanese accounts—which the Loochooans are far from accepting as fact—by a Loochooan of Japanese descent, under the following circumstances:—

In the spring of the year 1165, Minamoto Tamétomo, who had been living for some years in retirement in Oho-sima, whither he had been banished after the defeat of his family by the rival house of Taira, took ship and sailed westward in search of adventure. After a voyage of long duration, he arrived at the harbour of Unten, in the extreme north of the main island, Okinawa. He was received kindly by the Loochooans, and stayed on the island for seven or eight years, during which he gained the friendship of one of the local potentates, Ufuzato no Andzu, the lord of the district of Ufuzato, and married his daughter. Two years after the marriage his wife bore him a son, who, in 1190, succeeded to the Loochooan throne, taking the name of Shunten. The reasons given for his succession are briefly as follows:—The twenty-fifth of the old line of Loochooan kings was a man of feeble character, who allowed the administration to fall into a state of complete disorder. His misrule led to a revolution, in which he was deposed and killed by a powerful noble, named Rin, who seized the throne. But the latter was in his turn deposed by the son of Tamétomo, who, left in Loochoo as a child of six years of age, when he returned to Japan, gave evidence of so much ability as he grew up that, at the early age of 15, he was made lord of the district of Urasoyé. He was only 22 years of age when he ascended the Loochooan throne. Tamétomo is said to have instructed his son in the Japanese

syllabaries, and the latter is credited with their adoption in Loochoo.

There are several Japanese works (also one, if not more, Chinese books) which contain accounts of Loochoo, and in which mention is made of the intercourse which has taken place in past centuries between Loochoo and foreign countries. From a summary of extracts from these works, which are given in the "Okirawa Shi" (a recent work on Loochoo, written by a Japanese), it appears that the Japanese claim to have received tribute from Loochoo as early as the year A.D. 616, in the course of which several Loochooans arrived in Japan. Tribute was not then paid regularly, and consisted of articles of little value, principally palm-wood. The fragment of this tribute—if the occasional presents which marked the existence of friendly relations between the two countries may be called by that name—continued up to the year, A.D. 754, when the Empress Koken was on the Japanese throne. From that time till the year A.D. 1610, intercourse between the two countries appears to have ceased. It may be that the Japanese Government advanced claims to suzerainty which the Loochooans declined to admit. However, in the latter year, Loochoo was invaded and conquered by the Satsuma clan. The first attempt made by the Satsuma force to land at Nafwa was repulsed, and the invading force consequently landed at Unten, the northern harbour. The campaign is said to have lasted only 40 days.

The tribute then assumed a definite shape, the amount payable yearly to the Satsuma Treasury being between seven and eight thousand koku of rice. From this period also dates the custom of sending a congratulatory mission to Yedo on the accession of a new Shôgun to the Shôgunate. On these occasions, presents of silk, lacquer-ware, and Loochooan saké were made, and return presents were received by the members of the mission. In 1727, the tribute was increased to about 12,000 koku, which amount was collected annually by the Satsuma Han, until the year 1871, when the Han were abolished, and Ken established in their stead. Loochoo was then made a Han, and placed under the control of the Kagoshima Ken. The tribute continued to be levied on the same scale, with this difference, that instead of forming part of the revenue of the former—Satsuma Han—it was paid into the Ken exchequer, from which it found its way to the Finance Department at Tôkiô. In the following year, 1872, a mission arrived in Yedo to congratulate the Emperor on his assuming the direct control of the Government. Presents were exchanged between the two countries, and congratulatory epistles were presented to the Emperor and Empress of Japan by the King of Loochoo. In reply the latter received an Imperial message. This opened by stating that the climate and language of Loochoo were similar to those of Japan, and that as the King Shôtai held a high position, a fitting title was assigned to him, namely, that of King of the Loochoo Han, with rank amongst the nobility of Japan, and that in return he was expected to acquit himself well of his grave responsibilities, and render loyal assistance to the Crown. In the same year a further decree was issued, to the effect that the treaties concluded between Loochoo and the three foreign Powers of America, France, and Holland were to be considered henceforth as treaties made with the Imperial Government, and that as Loochoo was to be under the control of the Foreign Office, four Foreign Office officials would be stationed as residents in that country. A Yashiki was also assigned to them in Ida-machi, and the King was made an official of the first rank. The Loochooan Embassy then returned with the Japanese Foreign Office officials to their own country.

In 1873, Yonabara Oyakata, one of the Sandzukwan, accompanied by a suite of five subordinate officials and twenty attendants, was sent as Resident Commissioner, and established himself in the Loochooan Yashiki in Tôkiô.

During the first three years of his residence at the capital, it was customary for him to wait on the Emperor twice every year at the festival called the Tenchô Setsu, and at the New Year, when twenty pieces of silk cloth and thirty pieces of cotton cloth were presented. But, in 1876, this custom was abolished by the Japanese Government.

In the autumn of 1874, the Loochoan Han was placed under the Home-office, and at present a secretary of the Home-office resides in Nafwa, and conducts negotiations between the two Governments. The amount of tribute was also reduced by 400 koku.

China.—If certain ancient records may be taken as correct, the Chinese appear to have made several attempts in centuries past to open up intercourse with Loochoo. As far back as the year 606, a Chinese official sailed from the port of Foochow in search of adventures, and was the first of his countrymen to set foot in Loochoo. Being unable to converse with the natives of the island, he left almost immediately, abandoning one of his ship's crew, who was taken prisoner. The news of his reception would seem to have reached the ears of the Chinese Government, for, two years later, another official visited Loochoo and demanded that the Loochooans should tender their submission to China. This, however, they refused to do, and, accordingly, in the course of the next two years, a third Chinese mission arrived, bringing with them, it is stated, interpreters from Koron.* The Loochooans still proving obdurate, hostilities were commenced by the Chinese, who burnt a castle and carried off a number of prisoners.

The next we hear of relations between the two countries is more than 600 years after, in 1292, when some Chinese who landed at Nafwa were driven away by the natives with the loss of three men. For this outrage reprisals were promptly made in the same year, and in the raid which the Chinese undertook more than a hundred Loochooans were seized and brought back as captives to China. It was not till nearly a century later that the payment of tribute by Loochoo to China commenced. In 1314, a civil war broke out in Loochoo, which had the effect of dividing that country into three separate States, each with its own king; and some sixty years afterwards, in 1372, the Ming dynasty being in possession of the Chinese throne, a Chinese mission arrived in Loochoo, and yielding to the pressure put upon

* In Chinese, Kivenham, meaning "fabulous region."—E. H. G.

him, the King of the Loochooan State—Chiuzan—sent his younger brother with a letter to the Court of Peking. In this, he tendered his submission to the Chinese Emperor, and accepted his position as ruler of a vassal State. The kings of the other two States shortly afterwards followed the example thus given to them, and all three were confirmed in their titles as kings of the three States of Hokuzan, Chiuzan, and Nanzan.*

In the year 1428, Loochoo became united once more, under the rule of the king of the central State, and in the following year the number of tribute ships from Loochoo to China was fixed by the Chinese Government at two every alternate year; and it was settled that the complement of these should not exceed 150 persons. A Loochooan official residence was also established at Foochow, called the Hanshikwan (or residence of the Han ambassador).

In 1490, the number of the Loochooan mission, including the crews of the two vessels, was increased to 170 persons; and five more were added to the fifteen officials who had permission to accompany the tribute to Peking. Later on—the exact date is uncertain—the Chinese enacted the payment of tribute every year; but, in 1857, in consequence of a memorial on the subject from the King of Loochoo, the Chinese Government issued an order to the following effect:—That the tribute should be paid once every two years; that the number of the mission, all told, should not exceed 150 persons; and that of these only the Ambassador and Vice-Ambassador, with a following of 15 persons, should be allowed to visit Peking.

In 1678, the Loochooan Government petitioned the Chinese to be allowed to send another vessel, called a "sekkôsen," in company with the tribute ships, their object being evidently to secure increased facilities for trade. It is clear that the Loochooans at this time took advantage of the intercourse established with China by means of these tribute ships to carry on trade, for we read that in 1688 they memorialised the Chinese Government again, asking to be allowed to increase the number of the mission, and to conduct their trade free of duty. These requests were granted. The number of the mission was increased to 200 persons, and all customs duties on imports and exports were remitted. From this date till the year 1874, no important change was made in the tribute to China, except that of late years it became customary for the two tribute junks and the "sekkôsen" (as we may call the additional ship for the sake of distinction) to go in alternate years,† and that the number of officials who visited Peking was reduced to six, with a suite of six attendants. In the latter year, however, the Japanese Government issued an edict forbidding the payment of tribute in future to China.

Chinese Tribute.—Special missions were always sent to China whenever a new Chinese Emperor, or a new Loochooan King, ascended the throne. On these occasions the visit to Pekin was conducted with greater display, twice the usual number of officers being allowed to accompany the tribute to the Chinese Court.

* Also called Nan-zan.

† Thus, supposing the tribute junks to leave in the summer of this year, the "sekkôsen" would not leave till the following summer.

On ordinary occasions the number of the mission was 20, but the attendants were numerous, and these, together with the crews of the two tribute ships, brought the total up to two hundred persons. The sekkôsen carried eighty people.

Fourteen officials, including the Saifu and Head Interpreter, remained in Foochow (one official, the Resident Assistant Interpreter, being appointed to reside in that town for a term of two years, being replaced at the expiration of that period). The Ambassador (Taifu), Peking Interpreter, Peking Chief Secretary (Yoriki and Gisha), in all six, with six attendants, proceeded with the tribute to Peking.

The tribute paid on ordinary occasions consisted of—Sulphur, 12,600 catties; copper, 3,000 catties; tin, 1,000 catties.

The tribute paid on the accession of a king in Loochoo was as follows:—For the Chinese Emperor—2 golden tevru (ornaments), 1 suit of armour, 2 pair of gold-mounted swords, 2 pair of silver-mounted swords, 20 swords, 10 spears, 10 halberds (naginata), 1 suit of horse trappings, 2 gold-mounted screens, 100 gold-mounted fans, 200 silver-mounted fans, 200 ordinary fans, 200 packages of raw cotton, 300 pieces of silk, 100 pieces of cotton, 500 catties of copper, 500 catties of tin.

The tribute paid on the accession to the throne of a Chinese Emperor was as follows:—For the Emperor—1 pair of golden vases, 1 pair of silver vases, 4 swords (gold-mounted), 4 swords (silver-mounted), 200 pieces of silk, 2 pair of gold-worked screens, 200 fans, 5,000 pieces of paper for screens and walls, worked in fancy patterns, 500 catties of copper, 500 catties of tin. For the Empress—1 pair of gold boxes, 1 pair of silver boxes, 80 pieces of silk, 80 fans. For the ex-emperor or deceased emperor—100 riôs, in money. In return for this tribute, presents were given to the King of Loochoo, and to nearly every member of the mission, even down to the common attendants.

Other Foreign Intercourse.

The intercourse between Loochoo and other Foreign Powers has been very limited. In 1816, the islands were visited by H.M. ships *Alceste* and *Lyra*, and permission was received to bury on shore one of the sailors who had died during the stay of the vessels. Captain Hall, in his account of the Loochoos, speaks very highly of the kindness of the inhabitants, and states that although it was difficult at first to disarm the suspicions which the unexpected visit engendered, he ultimately succeeded in establishing the most friendly relations with the officials and people.

In the years 1844, 1846, and 1847, some French missionaries and an English doctor, were left on the main island by ships, the captains of which endeavoured to induce the Loochooans to trade with them, but without success, and in the ensuing ten years, other desultory visits were made by foreign vessels, in the course of which, several French missionaries were landed and left to reside, in some cases, for six or seven years. But these missionaries appear to have failed in their efforts to make converts, for, with the exception of one who died, all eventually left Loochoo.

In 1854, Commodore Perry, with an American squadron, visited Loochoo, and concluded a

treaty on behalf of the United States with that country, and in the years 1856 and 1859, respectively, similar treaties were negotiated by France and Holland. It is stated that the negotiations in each case were watched by emissaries of the Satsuma Han, who attended all the interviews as spies, attired in Loochooan dress.

Religion.

Loochoo has no state religion, but Confucianism, Buddhism, and Shintoism exist side by side, like Confucianism, Buddhism, and Mohamedanism in China. Confucianism is of the oldest date, and is the religion, so to speak, of the Court and upper classes, while all three are equally professed by the lower portion of the population. Ancestor worship, and the respect due to seniors, which is its natural outcome, are, more than any established creed, the guiding principles of Loochooan life. The two Buddhist sects, which have old establishments in Loochoo, are the Zen and Hokké. At Shiuri there are two or three temples, and the same at Nafwa. But, neither Buddhism nor Shintoism are regarded with much respect, and it is clear that they have no hold on the minds of the people. Both temples and shrines are of the rudest construction, offerings of devotees are conspicuous by their absence, and traces of persistent neglect are only too apparent everywhere. Of late years, a third sect of Buddhists has established itself in Nafwa, but owing to the determined opposition of the Government, the priests of this sect have not made much progress.

Schools.

There are 30 schools in Loochoo; 18 of these are in Shiuri, viz., one national school, for princes of the blood of Shizoku, from 18 or 19 years upwards; three Hira Gakkî, or district schools, for sons of noble families and Shizoku, from 17 and 18 downwards; and 14 Mura Gakkö, for sons of Shizoku and Heimin alike, from six or seven years upwards.

The course of instruction in these schools includes the Chinese classics, and the Japanese syllabaries. The school in Kirunei Mura, however, is set apart for the teaching of Chinese, and is attended by those who wish to become Chinese interpreters besides the inhabitants of that town.

Correspondence by letter is conducted both in the Japanese and in the Chinese style; but the latter is mostly affected by the higher classes, who receive special instruction in the different branches of Chinese education.

Women receive no instruction in reading and writing.

Weights and Measures.

The weights and measures used in Loochoo are based on those of Japan. The same terms are used both in square, lineal, cloth, and grain measure, and in calculating amounts of sugar; and with the exception of occasional differences such as dividing the "ei" into "go," "shaku" and "Sai"—a method which still prevails in Satsuma—the systems are the same.

Currency.

There is no gold or silver in Loochoo, and the only currency consists of the copper cash coined in Japan during the period of Kwanyei (A.D. 1624-44).

Previous to this period, all commercial transactions were carried on according to the primitive method of bartering one article for another. To remedy the inconvenience resulting from this way of proceeding, rice gradually became the standard by which values were estimated, and the relic of this custom exists to this day. The hire of a boat is fixed at so many "sho" of rice, according to the distance of the voyage. In 1694, the Loochooans petitioned the Satsuma Government to be allowed to issue a currency of their own, but the request was refused, and they were further prohibited from exporting the Japanese copper coins to China. During the visits of Chinese Envoys Chinese cash were used in defraying their expenses, and the Kwanyei currency was kept carefully concealed from their sight.

The language of Loochoo is closely allied to that of Japan, its affinity with the Satsuma dialect being very marked. It resembles Japanese in the polysyllabic character of its words, in the use of honorific suffixes with verbs, in the absence of the sound L, in its affirmative interjection Oo, which corresponds to the Hé, Hāi, Nĕ, Nă, &c., of Japan, and in the fact that, though the terminations are different, the roots of most of the verbs are the same. Add to this that numbers of words in the two languages, like Tai,* Uma, Ushi, are the same, and it will not be saying too much to assert that the language of Loochoo and that of Japan are identically the same in origin.

The chief differences between Loochooan and the present Tôkiô dialect in Japanese are as follows:—Ki in the Yedo dialect is replaced by Chi, H by F, Shi becomes Si, and O, in many words, becomes U. Examples of these changes may be found in the following words:—

Japanese.	Loochooan.
Kikimasenu (present tense negative form of verb "to hear").	Chichabrian.†
Gosho (castle).	Ushui.
Ozato (name of district).	Ufuzato.
Otoko (man).	Uyekega.
Shima (island).	Sima.
Heimin (collective name for lower classes).	Feimin.

The sound of F in Loochooan is peculiar. It is pronounced as if it was written Fw. There is another pecularity in the language which distinguishes it from any other known tongue. This is the extraordinary pronunciation given to vowels in certain words. The only thing to which it can be compared is the sound of a double consonant in Japanese, as expressed in the words "amma, onna." The peculiar accent rendered here in the case of the double consonants is given in the case of vowels. To take one or two instances, in the words "achinéyānchin" (merchant), "Fiyébara" (name of a district, "Samuréye" (Samurai), this peculiar pronunciation appears. It is a long drawl of the vowel, the tone of the voice of the person who speaks rising higher as the sound is uttered. The pronunciation cannot be rendered in words, and no system of trans-literation would convey it; it must

* Bird, horse, and cow.

† The connection between the terminal used here and the old Japanese terminal Habern is clear.

be heard to be understood. There are, of course, many words in Loochooan, such as "sidégafu" and "funaye" (thank you), and "Sō" (father), the origin of which is distinctly foreign.

GENERAL REMARKS.

It is well known that Loochoo has no standing army. There have been no soldiers since its subjection by Satsuma in the beginning of the seventeenth century. The coincidence of this date with the Satsuma invasion suggests the probability that one of the conditions enforced by the conquerors was that the population should in future be entirely unarmed. This condition, if it was enforced, has certainly been fulfilled to the letter—not a sword or an instrument of warfare of any kind is to be seen in the country; and the small guns which constituted the armament of the junks which used to make the voyage to China were borrowed from the Satsuma clan.

The roads in Loochoo are of a very poor description. Certainly the streets of the towns of Shiuri, Nafwa, Tonau, and Kumei are fairly well constructed, and the paved road leading from Nafwa to the castle at Shiuri, in spite of the irregularity with which the stone paving is laid, would compare favourably with some of the better class of roads in Japan. But, as soon as the traveller leaves the neighbourhood of the towns, and reaches the open country, the roads become mere tracks, quite impassable for any wheeled conveyance, and the absence of bridges is marked. The state of the roads is sufficient to account for the fact that such a thing as a cart is unknown in the country. The transport of produce is conducted either by pack-horses, or by coolies of both sexes—the women carring the load on their heads, while the men carry it slung on a pole as in China and Japan.

There are very few shops in Nafwa and the other towns, and none in the villages. Those which exist are of the poorest kind. The buying and selling of wares is carried on in the open air, and chiefly by women, each town having several market-places, in which numbers of primitive stalls are to be seen. A Loochooan stall is a very simple construction. A large umbrella is fixed upright in the ground, and serves as a protection against sun and rain. Underneath this sits the market woman with her stock-in-trade arranged before her in small trays or baskets. In some cases, and especially in wet weather, an additional barricade is made by propping up pieces of oil-paper, so as to form a screen all round the stall-keeper. The articles thus exhibited for sale are not such as afford any strong temptation to a purchaser, and consist chiefly of eatables of various kinds, fruit, meat, &c., and also toys and ornaments for the hair. The produce from the surrounding villages is brought in every morning by women to the towns and sold in the markets. Lacquer ware of a coarse kind and earthenware are made chiefly to order, and very little is to be seen exposed for sale in the shops of the manufacturers. There is only one village in Loochoo where potteries exist, and this is in the immediate neighbourhood of Nafwa.

Loochooan graves are similar to those in China, but the mode of interment differs. After death the body is placed in a large earthen jar, and deposited in the family vault, where it is left for three years, until it has become thoroughly decomposed. The jar is then taken out, and the bones being removed and washed, are put into another jar, and replaced in the tomb. As in China, it is customary to hire professional mourners, whose business it is to cry at funerals; but the burial service is conducted according to Buddhist rites.

The division of the people into the two classes of "Shizoku" and "Heimin" has been attended with the worst consequences; it has had the effect of enervating the one class and degrading the other. The Samurai of Japan formed a vast standing army; they were the product of a military system, which had for one of its objects the independence of the country; and though the privileges of their class were only maintained at the expense of the rest of the nation, there is no doubt that the military spirit thus fostered elevated the national character, and gave it a tone of independence which it otherwise would have lacked, and which can be traced in the Japanese farmer of the present day. In Loochoo the same class distinction exists, with all its faults and none of its advantages. The Shizoku of Loochoo has no spirit, no pride of country, and his pride even of self does not rise beyond the empty pharisaical boast that he is not a Heimin. The Heimin is an ignorant serf, who knowing that he is working for others and not for himself, has no heart in his labour, and lives from hand to mouth; and whose highest sentiment is a feeling of stupid respect for the privileged classes. The Loochooan Samurai is thus infinitely below his counterpart in Japan, while the peasant of Loochoo is even more immeasurably inferior to the Japanese farmer. Both classes live and think in the same grooves as centuries ago.

The hair-pin is the chief distinction between the two classes, that of the Shizoku being of silver, while that worn by the Heimin is made of brass. But there are other distinctions. Thus the Heimin is not allowed to wear clogs, he must not carry an umbrella as a protection from the sun, though he may use it in wet weather, and in the making of his clothes he is debarred from using cloth of certain patterns. Marriages between the two classes are very rare. There is one point, however, in which the Heimin of Loochoo had the advantage over the Japanese farmer under the feudal system. He is allowed to ride; and it is acknowledged that that the farmers are better riders than the Shizoku. At the races, which are held at stated times during the year, no prizes are given, but the losers dismount, and forming into line, salute the winner as he rides past.

I cannot leave this subject without pointing out what appears to me to be a curious fact in connection with the social division existing in Loochoo. This is, that while the men belonging to the Heimin classes are almost dwarfish in their stature, physical development, and the shape of their limbs, the Shizoku are, as a rule, fine big men, and are undeniably well made. Moreover, while the former in physiognomy resemble the Chinese, the latter have all the features of the higher classes in Japan. It may be that the degraded condition of the Heimin during many hundreds of years is sufficient to account for this distinction of feature and physical development,

but the existence of this clearly-marked difference leads one to suppose that a fusion of races has taken place at some remote period. I have been informed by a friend that he had occasion to observe the same thing amongst the Coreans.

That the hair-pin is one of the distinctions between the Shizoku and Heimin has been already stated. It serves to mark other differences of value. Thus, a Loochooan of the rank of Oyakata wears a hair-pin the head of which is gold but the rest silver. Again, that worn by the Sandzukwan and highest nobility is made entirely of gold.

The following explanation of the origin of the Loochooan hairdress is taken from a Japanese work on Loochoo:—

"In Japan, as it was in the reign of Saiko Kunô (A.D. 593—629), and before that date, it was customary for Japanese to wear hair-pins, which were worn in the queue, in a fashion similar to that now obtaining in Loochoo. The intercourse existing in that reign between Japan and Loochoo led to ranks and incomes being given by the Government of Japan to Loochooan nobles, and, as it was then customary in Japan to distinguish rank by the hair-pin, which was of gold or of silver, according to the status of the wearer, the practice was by degrees translated to Loochoo, and has continued up to the present time."

Relations between the Sexes.—The seclusion in which Loochooan women of the upper classes are kept is evidently a custom borrowed from China. It is considered a disgrace for a woman to be seen in public, and those who can afford the luxury never allow their wives to stir out of the house except in a covered palanquin. So strict are the rules affecting the intercourse between the two sexes that a Loochooan woman of the Shizoku class who meets an acquaintance of the other sex in the streets is not allowed to speak to him; both pass each other as if they were strangers. Nor is it considered proper for a man's wife to be seen by any visitor, except it be an intimate friend. To such a pitch is this feeling carried that persons have been known to live for years in the residence of a Loochooan without once meeting the mistress of the house.

In the construction of their towns the Loochooans resemble the Chinese and Coreans. It is true that the internal arrangement of a Loochooan house, in everything except the absence of cleanliness, is very similar to that of a Japanese dwelling. But here the similarity ends. In the roughly formed red and black or red and white tiles, of which the roofs are made, in the high walls, raised so that only the gables of the buildings are visible from the streets, in the arrangement of the courtyard, which suggests the idea of a fortification, and in the loftiness of the rooms, we see another influence at work. To any one coming from Japan, the first sight of a Loochooan town is rather pleasing, probably because it is so very different to anything in Japan; but, after a time, the long lines of walls on each side become excessively wearisome to the eye, and one misses the tasteful arrangement of garden and fence, which are such a pleasing feature in Japanese towns. The Loochooans, however, cling to their walls as to all their other peculiarities. They serve, so they say, "As a protection against fire, wind, and thieves, as boundaries between streets and compounds, and are useful in the interests of privacy." The last advantage is, probably, that which carries most weight.

Shiuri.

Those who in Shiuri expect to see anything remarkable, either in architecture or in any other respect, such as is generally to be met with in the capital of a country, will be disappointed. Distant only two and a-half miles from the Port of Nafwa, its white towers are clearly visible from the anchorage. The town is grouped picturesquely on the slopes of a hill, on the west of which stands the palace, or castle, commanding a fine view of the sea to the south and west. The grounds of the palace are enclosed within a high wall, and there are two gates by which access can be had to the interior. The principal entrance is through a gate, which opens on to the high road from Nafwa. After passing through four gates, always ascending, the visitor finds himself in a large courtyard, some 60 yards by 30, paved with red tiles, placed closely together, and laid so as not to cover the whole space enclosed, but to form a series of walks. Facing the entrance is the audience hall, or Shô-in. This building resembles in shape the large gateways built at the entrance of Japanese temples; the front walls are painted red and blue, and the roof is tiled in the ordinary manner. Anything more ugly can hardly be conceived. To the left are the offices of the Council of State, the principal hall of which is used as a guest-chamber. The ceiling and panels of this room are ornamented with roughly painted representations of tigers, cranes, and deer. To the right of the entrance is a low building, containing a suite of rooms occupied by members of the royal household, and through these a passage leads to the king's apartments, which are at the back of the audience-hall. The grounds of the castle are picturesque, and show evidences of former taste and care in construction, but little attention appears now to be bestowed in this direction. The situation has much to recommend it. From the ramparts of the castle we looked out on a succession of bright green hills, sloping down to the sea, or uplands rich with barley and sugar-cane, and valleys filled with rice; and when we turned from this charming prospect and observed the marks of decay everywhere—the untrimmed walks and shrubberies of tropical luxuriance choked with weeds—we could not help thinking that where nature had done so much, man might do a little more.

The streets of Shiuri, like the roads elsewhere, are paved with stone, and, as the town is built on a hill, and the Loochooan idea of road-making is that a road should lead straight up to the top of a hill and straight down again on the other side, great precaution is needed so as to walk without falling. The Loochooans claim a great age for the castle at Shiuri, and state that the buildings which stand now are, except for the fact that they have been repaired whenever necessary, identically the same that were originally erected. It is not improbable that the castle stands much as it stood 600 years ago. The population of Shiuri is about 40,000, of whom three-fourths are Shizoku. I give these figures on the authority of my Loochooan informants, but they appear rather high, and 30,000 would probably be nearer the mark.

Paper on which anything has been written is

held in great respect, and small stone erections in the shape of boxes are to be seen by the road side. These are provided with cavities in which any old scraps of paper, on which characters have been traced, are placed and burnt. It is considered highly improper to throw such pieces of paper away. In spite of this custom, which would seem to point to a great respect for literature on the part of the Loochooans, it is a singular fact that there are no book shops anywhere in Loochoo. The only printed book is the calendar which it is customary for the Loochooan Government to issue provisionally every year, until the Chinese calendar is obtained from Peking.

In their shipbuilding the Loochooans have adhered to the Chinese model, and it is the exception to see the vessel rigged in Japanese fashion. The tribute junks which used to cross over to Foochow, and the sugar junks which, until the last year or two when they have been superseded by steamers, carried the sugar to the markets in Kagoshima and Osaka, are large vessels some 80 or 90 feet in length, with a beam measurement of 20 feet, and a similar depth of hold. In every respect they are like Chinese junks even to the eyes painted in a conspicuous place.

DISCUSSION.

The Chairman said there was so much matter in the paper that it was very difficult to discuss it thoroughly; but it would be very valuable, when printed, for future reference.

Mr. Christopher Cooke said it was the opinion of the late Mr. Cobden that, if he went down to the Universites of Oxford or Cambridge, and asked any of the students where Chicago was, not one in a hundred would be able to answer him. He thought the same observation would apply to Loochoo; but he remembered reading of it as a boy in Captain Hall's voyages, and had lately looked up the book and made a few notes, which might be interesting. The Captain had fixed the latitude and longitude exactly, said the religion was similar to that of the Chinese, and that there was an observatory there. Polygamy was only permitted to the king, and the women were hardly used. Capt. Maxwell, of the *Alceste*, broke his finger, which was dressed by the native doctor with a paste made of eggs and flour, and it was then wrapped in a hen's skin. Captain Maxwell made a present of a thermometer, and Captain Hall of a Cornelian seal, which were carefully preserved. He also said that there were no deformed or diseased persons visible, except a few who were marked with the small-pox. He referred expecially to the honesty of the natives, for when a watch, which had excited great curiosity, got mislaid, and it was feared it was lost, it was brought back next morning, and the bringer refused to take any reward. Captain Hall left them a sextant, and instructed them how to use it.

The Chairman remarked that there were few more interesting books than Captain Hall's travels. In connection with Loochoo, he remembered his narrating that on his homeward voyage he touched at St. Helena, where Napoleon was then residing, and found that the ex-Emperor was much interested in hearing of these travels; but when he was told that in Loochoo there were neither soldiers nor arms, it was quite beyond his comprehension.

Mr. Hale said they were much indebted to the author of the paper, but there was perhaps one oversight in it, inasmuch as there were no means of judging of the values of articles in English money. It was very interesting to hear of a nation where there was no army, for he believed the worst expenditure of any country was that on armaments, though it might be necessary.

Mr. Hyde Clarke said it would no doubt be desirable to reduce the few prices and quantities given in the paper into their English equivalents. The sugar crop was very considerable according to the figures given, but the price was very low. He did not know why everybody should be supposed to know the exact locality of every place on the globe; but the book to which Mr. Cooke had referred was at one time very familiar, and no doubt thousands of copies were in existence. Since it was published, however, many other places had grown up into more importance, and the instance given of Chicago was very much to the point. It had rapidly sprung up into an immense city, whilst Loochoo had remained practically stationary. The relations of the Loochoo language were, of course, the same as those of the Japanese, as they are allied languages or dialects. Mr. Aston, a distinguished scholar of the Japanese Consular Service, had given in the last volume of the "Transactions" of the Royal Asiatic Society, a most valuable paper on the relations of the Japanese to the Korean. The Korean, and others in Western Asia, and also in America, were allied; but for reasons into which he need not go, it was requisite to go further afield, in what are called Turanian languages, to ascertain the real position of the Japanese, and, consequently, of the Loochoo. With this he had dealt at some length, as quoted by Sir E. J. Reed, M.P., in his paper, and particularly in his appendix to the second volume. The result at which he had arrived, was that the Japanese belonged to that earliest epoch of cultivation, in which were placed the Akkad-Babylonian, the Khita (with some Hittite), the Egyptian, Etruscan, Chinese, &c. All such as these have words which are identical, but these resemblances are distributed in various proportions. The cause was that the words were not derived from one primeval language of identical roots, as generally conceived, but from a variety of words for the same idea. The identity was not to be traced so clearly by similarity of sound as by identity of psychological relations. Thus if we examined the Japanese or Loochoo numerals, 3 will correspond with Ear, 4 with Good, 8 with Arrow, 10 with Far. These were widely distributed laws of prehistoric language, dependent on various circumstances. In a system of numerations in which the eye figured as 2, the ear was 3. The Japanese have not preserved the relations of 2, but they have of 3. The arrow in the ancient Fetish mythology had a numeral relative, as all weapons and other objects have. Although we cannot, at present, trace Japanese and Loochoo migrations in detail, we know this, with certainty, that the origin of the language and mythology was most ancient, and constituted in forms corresponding with those of the founders of civilisation in the old world. At the present moment the difficulties of tracing each movement or phenomenon were very great, because many ancient forms are unknown; but with the advance of knowledge, we should, no doubt, obtain fuller results. At all events, it might be determined that we were not to regard Japanese as derived from Korean or from Chinese.

Mr. Sayematzu said there was a great resemblance between the language of Japan and Loochoo; and he had been told by a gentleman from the southern part of Japan that he had been in Loochoo, and that there were very many words which were identical. The most remarkable coincidences were the numerals. He did not say that the Loohcooan came from Japan, because the Japanese must have come from Loochoo. The date of the conquest of Loochoo by the Japanese was the 11th century, and even before that there were

records relating to the island. The fact that the king of Loochoo paid homage to China as well as to Japan could not be taken to be of much value, because in China all diplomatic messengers were said to be bringers of tribute; and probably on the same ground even England might be claimed as a tributary of the celestial empire. Japan actually conquered the island a little over 300 years ago; before that the King of Loochoo used to send tribute to Japan, but at that time, owing to internal disturbances, he neglected to do so. When tranquility was restored in Japan, and war was made on the Korea and China, the King of Loochoo was ordered to pay a share of the expenses, and as he did not do this, the Japanese Government sent and conquered the island. Since that time no doubt a certain tribute had been sent to China, but it was never recognised by Japan. Considering the position of Loochoo, it was very important to Japan that it should not be under foreign influence, and therefore when it was apparent that the king was still keeping up relations with China, the Japanese Government could not pass it by, and that was the origin of the so-called annexation.

Mr. Pfoundes said these islands were, in the first instance, made known to Europeans by the early voyages of Albuquerque. The Portugese entered the Chinese sea about 1511, and, about 1516, they got as far as Canton. Albuquerque, the first Governor-General of the Philippine Islands, sent out an expedition in 1517, which, in the Formosa Channel, fell in with the Loochoo junks, which, it was supposed, were making their annual voyage to Loochoo. It was then a question with the Portuguese whether they might not push forward as far as Japan, which had been so much spoken of by Marco Polo, but their outrages on the coast where they landed, caused the repeated destruction of their settlements in the first year of the 16th century, and they were finally driven down towards Macao; their ill-repute gradually spread through the islands up to Japan, and intercourse with them was more or less cut off. The information with regard to Loochoo had been very admirably condensed in the paper, and there were very many points he should have liked to touch upon had time permitted. Every one would agree that it was a specimen of the first-class work done by the gentlemen of the Consular service, and he must, himself, tender his thanks to the Chairman for allowing him to make researches which were of the greatest interest. These islands, though they appeared very small on a Mercator chart, were in reality of considerable importance, and would prove still more so in future. Dr. Beltelhemier, when he landed, found some nuisances there, but though no doubt his conduct was very heroic in remaining for a long time in the face of annoyances purposely inflicted in order to make him leave the island, he feared he had not that tact which was requisite for making successful efforts in the country. This was one reason why so little had been done by medical or purely religious missionaries. The eminent Chinese scholar, Mr. Alexander Wylie, told him that he knew of the existence of a Hebrew manuscript, written by Dr. Beltelhemier, addressed to the Hebrews in China, but as the fact was there were no Jews in China, he believed it still remained undelivered in the hands of some of the missionary authorities.

The Chairman said the paper was a very suggestive one, but no doubt it would be improved by the addition of the English equations for the measures and prices. He had tried to roughly do this, and he found that the area of Loochoo was rather less than 1,000 square miles, and the population 166,000, which was very large for so small an area, considering that a great part was barren rock. The annual production might be estimated roughly at £100,000, which was probably a low estimate; it struck him as being exceedingly low—scarcely more than 12s. per head. He had no doubt, however, that the production was very low, as the condition of the people was really one of considerable poverty. Their import and export trade amounted, in round numbers, to something like £77,000, which was very small for such a population. The value of the sugar was not such as would have any appreciable effect on our consumption, being about £20,000. He thought the quantity was probably rather less than 3,000 tons. It was a dark, black kind of sugar, only used by the Japanese, and they used much more Chinese sugar, which was of a better quality. There could hardly be two more opposite instances than Chicago and Loochoo—of progress on the one hand, and stagnation and political inanition on the other. No doubt Loochoo had a very ancient history, for the disputes about it between the Japanese and Chinese went back as far as the 6th century. Japan collected tribute in A.D. 616, and China attacked and conquered it in A.D. 620. Although so small a territory, it was then divided into three rival States, and he had seen one of the old castles which formed the stronghold of one of those three States, and was much struck with its enormous strength. It was built of immense stones, put together without mortar. The state of this island showed the result of non-communication with the world. There were very few nations now existing which had excluded themselves from the rest of the world, but they were always found to have become stagnant and gone down hill—become fossils as it were. Loochoo was in that condition, but he hoped that a new epoch would now begin, and that fresh vigour would be shown. Living alone, having nothing to do but to make laws for themselves, they went into most minute details, and made the most elaborate form of Government, embracing so many departments that Dr. Mann had judiciously omitted reading many of them. There was a Herald's office, Woods and Forests, a Lord Chamberlain, and every description of office, and, in fact, that seemed the only way they had of employing their time. It was a curious fact that this small population was divided into two classes, nearly in the proportion of half and half, so that nearly one half, viz., the official class, were entirely unproductive. This must explain how it was the population could be kept in order without any particular military display. The absence of arms, though at first sight it might seem to indicate a happy state of things, had not been able to keep Loochoo from annexation, and he feared that, until the millenium arrived, armies would be necessary to nations which desired to retain their independence. The relations between Loochoo and China and Japan were very interesting, and with regard to the language, there was room for much further study, because there were traces of an earlier language and an earlier character. He had found stones there bearing inscriptions which were neither Japanese nor Chinese, and which the inhabitants said was the ancient Loochoo language. He hoped the gentlemen in the Consular service would continue their efforts to investigate these matters, and ultimately succeed in tracing, not only the present dialects, but the pre-existing ones. In this case they had a nation still extant, coeval with pre-historic times, and it would be very interesting to trace the origin of the language, and see whether it came from the north or the south. It was certain that at one time a tide of population set in from the south to the north, for a strong Polynesian element ran through all the islands, right up to Japan. He concluded by moving a vote of thanks to Mr. Gubbins for his paper, which was carried unanimously.

Dr. Mann said that he had reason to hope the kind service rendered to the Society by the Chairman this evening, would be supplemented by a further contribution regarding the commerce of Japan in some future session.

The Chairman said it would give him great pleasure to communicate any information he could glean to so practical a Society.

MISCELLANEOUS.

THE PRODUCTION AND PREPARATION OF SALT IN ITALY.

The industry of the preparation of sea salt in Italy is, according to a report recently issued by the United States Consul at Milan, in a most flourishing condition, as in addition to supplying the wants of the Italian people themselves, there is annually exported about 150,000 tons, exclusive of the productions of Sardinia and Sicily, where there exists no Government monopoly, and from these islands about 100,000 tons are annually exported. The cost of production of common salt averages fifteen lire the ton, and it is estimated that the Government realises a profit from this article of 68,000,000 lire annually. The places of production in Italy are eleven, and almost all are Government property; a part are let to private industry, while five are managed directly by the State. The former are at Cagliari, Convecchio, Volterra, Salso-Maggiore, San Felice, and Trapani; the latter at Margherita, Savoy, Corneto, Cervia, Lungro, and Portoferrago. In order to hasten the evaporation and produce a good article of natural salt, which is the main object of artificial salt production, a large expanse of level ground, close to the sea, and as near as possible to the sea level, is selected. Enclosed by high dykes to prevent flooding from high seas or storms, the surface is subdivided into numerous levels, separated by little banks, as is practised in the cultivation of rice. The entire extent of the salt farms is in communication with the sea by means of a canal, which serves for the ingress of the sea water and egress of the rain-water, and sometimes hydraulic pressure is used to empty or fill the basin. Numerous lines of canals and ditches run in several directions through the extent of the evaporating ground, and it is by these that the water is guided through the different levels. In April the rays of the sun begin to gain force, and the equinoctial storms having passed, the damages of the past winter are repaired, and the rain water that may have collected is pumped out, generally by hydraulic elevators, worked by centrifugal force. The rain water having been ejected, the canal to the sea lets in the salt water, which should cover the ground to the depth of about two inches, The various levels of the salt farm should be of a difference of about three inches, one above the other, so that the water may circulate slowly and freely over the whole expanse. The water, exposed to the rays of the sun, and under the influence of the wind, evaporates, and as it diminishes in volume it increases in density, and it is to facilitate this process that the salt farm is constructed and the water passed from one level to another, until it has acquired the desired density, after which it is reunited in deep reservoirs. This process, many times repeated, lasts all through the month of May; it is in the month of June that the real work of manipulating the water for the production of salt begins. The water collected in the reservoir, and showing 15° to 20° Baumé of density, is pumped out into other large flat reservoirs until, by evaporation, it acquires 25° of density; it is then spread over the salt-producing portion of the farm in extensive reservoirs, of from 5,000 to 10,000 square yards, to the depth of two inches. The evaporation by the sun and wind concentrates the water, and causes the salt to be deposited; small points are seen forming in the water, which enlarge into crystals and sink to the bottom, where they increase by the addition of other crystals; this process is slow and continuous, when not interfered with by extraneous causes. The salt reservoirs keep this large flat expanse continually filled with water to the depth of about two inches; the earth at the bottom begins to whiten, and a crust of deposits is found at the bottom of the water, which augments day by day, until by the month of August it becomes from two to three inches thick. The crop is then gathered, as a rain storm would destroy a portion of it; the superficial water is drawn off, leaving a deposit of salt, which is of a pure white, and shines like crystallised snow. The workmen then enter the salt farms, and with hoes, picks, and shovels separate the crust of salt from the earth, and carry it to the magazines in sacks, barrels, and carts. This work lasts more than a month, sometimes continuing until September, and it is necessary to employ a very large number of men, as a change of weather would have injurious results in the harvest of salt. During the whole of September and a great part of October, the soil of the reservoirs is washed out, and the water deposited in deep reservoirs, where it remains until the next year; the crystals that have been formed are, however, filled with impurities, and have to be subjected to the action of rain water during the winter, before they become saleable. As regards artificial evaporation, the principle that regulates the production of salt by artificial means is practically the same, but the manner of producing it is different, as the expensive process of reduction by fire is adopted. In various parts of Italy, at different depths, are found layers of salt, evidently deposited at remote periods, in strata, or mixed with heterogeneous materials. In all the wells in these localities the water is strongly impregnated with salt. The only two places in Italy where salt is worked by artificial means are Volterra and Salso-Maggiore, the former having wells 40 yards deep, often connected by underground galleries, and the latter an artesian well, of the depth of 300 yards. The water, on being pumped out, is deposited in large reservoirs, and afterwards in very large open boilers, under which fires are continually kept burning. The advantage of this system is its practicability at all seasons, and its independence of the weather, but the production of salt is much more expensive. The salt deposited and scraped up from the bottom of the boilers is of the whitest quality, but less granulated than the sea-salt, and is sold throughout Tuscany and in other places at the price of that passed through the mill. The salt wells of Volterra produce annually more than 10,000 tons, and those of Salso-Maggiore about 1,000 tons only. The salt of Volterra, on account of its purity, is mostly used for table purposes.

At Lungro, in Calabria, there is a salt mine which employs 400 hands; here the deposits are found in strata slightly mixed with extraneous matter of various formations, horizontal, perpendicular, and often in caves or pockets. This mine dates from ancient times, and has been often abandoned, but is at the present time in a flourishing condition. It is situated at the bottom of a valley, about 300 yards above the level of the sea, and is entered by a small aperture of about three square yards in the side of the Apennines. This tunnel, after a short distance, communicates with a subterranean gallery, descending by easy gradations and steps to the depth of 200 yards; connecting galleries and drifts lead in every direction, and the salt is extracted by blasting, and then broken up into fragments of convenient size for porterage. This mine produces about 7,000 tons annually, which is principally consumed in Calabria and the Basilicata; it is compact, pure, and white, like chalk, and translucent. The largest salt works in Italy are those of Cagliari, producing annually more than 130,000 tons of salt. On the coast between Marsala and Trapani, in Sicily, there are many private salt farms, and as no Government monopoly exists, any one is at liberty to cultivate this industry on his own lands. The salt farms of Trapani supply Rome, Naples, and Venice, besides exporting

annually about 60,000 tons. Convecchio and San Felice produce together 15,000 tons of salt, and the two salt springs of artificial evaporation, Volterra and Salso-Maggiore, produce annually about 10,000 tons, and supply nearly all Tuscany and Parmigiano. Of the salt springs administered by the State, first in importance is that of Margherita, producing 30,000 tons; Lungro, producing 6,000 tons; Portoferrago, 2,500; Cervia, 8,000; and Corneto, 6,000 tons. These are all worked by a body of technical *employés* serving under the Minister of Finance. Consul Crain states that since the year 1870, a complete reorganisation has take place in the management of this industry, producing good results. In the year 1877, the sum of 80,420,205 lire was received from the sale of salt, which, deducting expenses amounting to 13,579,242 lire, leaves a net profit of 66,840,963 lire, realised by the Italian Government.

KAURI GUM OF NEW ZEALAND.

Consul Griffin, of Auckland, has written a full report on the production of kauri gum, which is largely used for the manufacture of varnish, of which the following is an abstract:—

It consists of the dried and solidified sap of the kauri tree, a species of pine known to botanists as the *Dammara australis*. It is found only in the province of Auckland, in that part of the colony lying to the northward of the thirty-ninth degree of south latitude, and does not exist in any other part of the world. The largest quantity of marketable kauri gum is dug out of the ground. It is found at various depths, from just above the surface of the soil to many feet below the surface. It is found on bare hillsides, on flat clay lands, in swamps, and even in some places that are covered with a more or less thick coating of volcanic *débris*. Sometimes the gum is found in small detached lumps, and at other times large deposits will be found in one hole. On cultivated land it is not unfrequently turned up by the plough, and in many places the cutting of large drains in swamps has revealed large deposits of this vegetable product. In the forks of the large branches deposits varying from a few pounds to nearly a hundredweight are sometimes met with. When a kauri tree is cut in the bark, even one of the largest and oldest, varying in diameter from six to ten or twelve feet, it will bleed like a young sapling. In a few weeks, if the weather be dry, a large mass of half-dried gum will have oozed from the wound, not unfrequently appearing in the form of a great thick band, reaching from the wound to the surface of the soil around the tree. When a tree is felled, the stump bleeds in a like manner until large masses of gum can be broken off from the stump. This "young" gum is white in colour, and has not the rich amber colour which age imparts to it when stored beneath the surface of the soil away from the action of sun and weather.

The gum is not soluble in water, It ignites freely, and burns with a lively sooty flame. It froths and bubbles, and produces a pleasant aromatic odour. The perfume it exhales when burning in the open air is not unlike that of frankincense and myrrh.

Some of the finer specimens of kauri gum are used in the manufacture of jewellery, but, while it is very clear and beautiful, it is not so desirable for this purpose as amber. It is not nearly so hard as the latter, and it is much more brittle, and insects and plants are not so frequently found imbedded in it.

Kauri gum was known to the native race long before the island were settled by Europeans. They used it for the purpose of kindling their fires, and it is also said to have been employed by them in their religious rites, but there does not appear to be any ground for the statement. Kauri gum became an article of commerce immediately after New Zealand became a British colony. At first the exports were small, amounting to about 100 tons per annum. The price of gum at that time ranged from £5 2s. to £5 19s. per ton. The natives then were the only persons engaged in searching for it and bringing it to market.

The implements used in digging for the gum consists of a spade and a spear. The spear is a long steel rod, about half an in inch in diameter, with a wooden handle with a cross on the top, like that of a spade or a shovel. The rod is brought to a point, and the gum digger pierces it into the ground. Practice and experience enable him to tell whether he is touching a stone or a piece of gum. When he touches the gum he digs around it until it is extricated, and then renews the search as before. The number of persons regularly engaged in digging gum varies from 1,800 to 3,000, the greater part of whom are Maories, but even they do not show any special fondness for the work. They resort to it when they become pressed for food and clothing on account of the failure of their crops, or other causes. Many Europeans have resorted to this kind of work, but they belong generally to a class who are unruly and impatient of the restraints which a civilised life imposes upon them, and who prefer to camp out after the fashion of gipsies, and live in tents and ranpo huts rather than in houses fitted for civilised beings. It is generally supposed that a European who resorts to gum-digging is unfitted for any other occupation. He leads a reckless, dare-devil sort of life, away from friends and kindred, and from the restraints of civilisation.

When the gum is taken out of the ground, it is covered with earth, and its surface is found to be in a partial state of decay. When the digger is tired of work, he puts his gum into a bag and carries it to his tent or hut, and in the evening or upon rainy days he, with the assistance of his wife and children, scrapes off the decayed surface until the clear solid gum beneath is reached. When a sufficient quantity of it has been scraped, it is put into a box or bag and taken to the nearest store or public house, where it is sold for what it will bring. Sometimes the purchaser will assort it, but it is not generally sorted till it reaches the city buyer, who employs a large number of skilled hands for that purpose. The gum, after it is scraped and assorted, is packed carefully in boxes, so as to prevent the lumps from breaking. It is then ready for export. The dust and scrapings are also exported.

Some of the gum is used in New Zealand for the manufacture of varnish, but in no great quantity. The export of kauri gum for the year 1880 is larger than that of any other year. The total export for 1878 was 3,410 tons, and 3,247 tons was the total export for 1879. The invoices thus far received indicate that the total shipment for the year 1880 will be 5,500 tons. The price of gum ranges, according to the *Scientific American*, from 144 dols. to 720 dols. per ton. The greater part of it, however, is bought at the former price. The average price may be safely set down at 216 dols. per ton. At this rate the total value of the estimated shipment for the year 1880, viz., 5,500 tons, would be 1,188,000 dols. More than two-thirds of the gum goes to the United States. It is either shipped to New York and Boston in sailing vessels, or to London for transshipment to the American cities.

It is a matter of regret, adds Mr. Griffin, that the kauri forests are disappearing. The trees are being so rapidly cut down that they will soon cease to exist. The Government has not taken any steps to protect them, either by conserving those that remain or by planting new ones. At the present rate of consumption, fifty or eighty years will see the bulk of the kauri trees cut down. Of course, when the trees are destroyed there can be no deposits, and kauri gum will become a thing of the past. The amount of gum taken out of the soil up to the present time has been so great, Mr. Griffin concludes, that it would probably require a forest growth of ten thousand years to replace it.

THE ENGLISH MILE.

Mons. Faye lately read a paper on the "English Mile" before the Academy of Sciences of Paris, and the following translation is taken from *Nature*:—

It is known that the mile of 1,609 metres long passed among English geographers and navigators as being the length of the terrestrial arc of 1′; in other words, they made the degree equal to 60 of these miles. In reality it contains 69·5; there is thus an error of about one-sixth. This error, if it existed long among our neighbours, which I do not know, must have caused many a shipwreck. It has had another very remarkable result; it nipped in the bud the discovery of the law of universal attraction. The first time that Newton's great idea presented itself to his mind the proof failed him, because he made use of the common English mile to calculate the radius of the earth. He renounced the idea for a long time, and only took the calculation up again when he learned the results of Picard's measurement of a degree in France. Whence comes this defective estimate? Certainly it does not proceed from any defective measurement, for the worst degree measurements, among those which have been really made, and not fictitious measurements, like that of Posidonius, are far from presenting errors of such magnitude. English geographers, then, must have committed some mistake in taking their mile from ancient documents.

So long as navigation was limited to the waters of the Mediterranean, and to coasting along the western shores of Europe, it was scarcely necessary to trouble about the value of this element; but from the time that the discoveries of the Spaniards and Portuguese opened out a much vaster field, sailors were compelled to make some inquiry into the matter. I suppose that the English navigators applied to their geographers, and that these found nothing better to consult than Ptolemy, the great, the only authority in these matters. But Ptolemy himself refers to Eratosthenes; he says that he verified the measurements of the latter and found the same result, viz., 500 stadia for the terrestrial degree. I have thus been led to examine the measurement of Eratosthenes. According to the documents which historians have preserved, Eratosthenes measured the great arc of meridian which separates the parallels of Syené and Alexandria, and finally found 700 stadia to the degree. This is how he worked: — He observed at Alexandria, certainly by means of a gnomon, the zenith distance of the sea at midday in the summer equinox, and thus found 7° 12′. It is added that at Syené the bottom of the wells was fully lighted by the sun on that day, so that Eratosthenes concluded zero for the zenith distance of that body. I believe rather that the Greek astronomer caused an observation to be made at Syené with a gnomon, an instrument then very common in Egypt, and that that distance resulted from an effective observation, as well as in the case of Alexandria. We shall see that this conjecture is perfectly justified. We know that the observations made on the dark shadow of a gnomon bear a constant error equal to the semi-diameter of the sun, or, to speak more accurately, that they give the zenith distance of the upper edge of that body. The ancients do not seem to have remarked this; and in fact, as they deduced from their observations only the obliquity of the ecliptic or the epoch of the solstice, it did not concern them, for, by combining the observations of the summer with that of the winter solstice, the error in question disappeared from the difference. But it is exactly the same here, since we have not to do with absolute latitude, but with the difference of latitude of two places at which the centre of the sun is found at midday on the same side of the vertical. Thus the amplitude 7° 12′ concluded by Eratosthenes is correct; it has moreover the advantage of not being sensibly affected by refraction.

Here is a first verification. On opening the *Connaissance des Temps* we find—

	°	′
For the latitude of Alexandria	31	12
,, ,, Syené	24	5
Difference	7	7

instead of 7° 12′. The difference, whatever may be the cause, is very small.

Here is a second and more delicate verification. The latitude of the point in Alexandria, where Eratosthenes observed, could not differ much from that which we have given. By adopting that and 7° 12′ for the zenith distance of the upper edge of the sun at the winter solstice we find 31° 12′ — (7° 12′ + 16′) = 23° 44′ for the obliquity of the ecliptic. Syené gives 24° 5′ — 16′ = 23° 49′. It is possible that in the year 250 B.C. the obliquity of the ecliptic was from 23° 44′ to 23° 49′? From 1750 A.D. to 250 B.C. is 2,000 years. At the rate of 48″ diminution per century the obliquity would be 23° 28′ 18″ + 48″ × 20 = 23° 44′. The observation of Eratosthenes at Alexandria is then authentic, and, moreover, very precise. That of Syené presents an error of only 5′.

There remains the geodetic operation. Egypt was the only country of antiquity which rejoiced in a survey. The valley of the Nile was very populous at that epoch, as far as Syené, and no doubt the survey extended thus far. Eratosthenes must have had every facility for procuring the necessary documents. He must have taken into account the difference of longitude of 2° 59′ which exists between the two cities, without having had to determine it directly. I regard, then, the distance of 5,000 stadia, in round numbers, as being quite as accurate as the other part of his operation, and as applying to the arc of meridian comprised between the parallels of the two cities.

We finally conclude from this 694·4 stadia for the degree. The Greek astronomer gave, in round numbers, 700 stadia. What was this stadium? To reply to this question I calculate the arc of meridian from Alexandria to the parallel of Syené, with the actual element of the terrestrial ellipsoid. It is 797,760 metres. At the rate of 5,000 stadia we find 159,55 metres for the stadium. At the rate of 600 feet for the stadium, the foot adopted by Eratosthenes would be 0 266 metres. This was then the ancient Egyptian foot, which we now reckon at 0·27 metre; and, in fact, it was with this foot that the survey of Egypt must have been made. By this reckoning the 5,000 stadia give 5,000 × 600 × 0·27 = 810,000 metres, showing a difference of 12,240 metres, partly owing to that of the points of departure, partly to the error which we perhaps make in the length of the Egyptian foot in carrying it to 0·27 metre. Thus the measurement made in Egypt, more than 2,100 years ago, by an able Greek astronomer, is as good as authentic. All the existing causes of uncertainty do not alter it more than one-sixth. It is certainly not from this quarter that the error can come for which we seek.

Nor is it in the measurement of Ptolemy, for he tells us he went through the same operations and found the same results; only he gives 500 stadia to the degree instead of 700. This difference is evidently due to the fact that Ptolemy, who lived 400 years after Eratosthenes, under another domination, did not make use of the same foot. In fact he employed the stadium of 600 Phileterian feet, and as this foot is about 0·36 metre, while the ancient Egyptian foot was only 0·27 metre, he had to reduce 700 stadia of his predecessor to $700 \times \frac{27}{36} =$ 525, or 500 in round numbers.

These estimates are confirmed, finally, by the Arabian astronomers, who measured, in 827 A.D., an arc of 1° in the plains of Mesopotamia. They found fifty-six miles, and concluded that they had thus verified the number of Ptolemy. The Arab mile being 2,100 metres, the arc

measured is found to be 117,600 metres, which corresponds to a stadium of 235 metres. This is very nearly the Phileterian stadium of 216 metres, except the error of the measurements seven times more sensible on so small an axis, and the uncertainty of our existing estimate of the Arabian mile in the time of the Kalif Almamoun.

To resume: the estimate of Ptolemy is only a sort of conversion of the excellent measurement of Eratosthenes in units of another epoch and of different length. It would thus lose a little of its first precision; but, such as we find it in Ptolemy, the English geographers were fully justified in taking it for the basis of a valuation of the arc of 1′ and of offering it to the navigators of their country. Only, and it is here the mistake lies, they believed that the great Greek astronomer of Alexandria must have made use of the Greek foot. This is one and a half hundredths larger than the English foot. If the English geographers of the sixteenth century had strained this valuation ever so little, and had carried it to $\frac{5}{100}$ths, they would have found 630 English feet for the stadium, which they believed to be 600 Greek feet, and these 630 feet or 210 yards, multiplied by 500, would give them 105,000 yards for the degree and exactly 1,760 yards for the mile. The English mile, then, has evidently been deduced from the measure of Ptolemy; its error of one-sixth is solely due to the fact that the Greek foot has been confounded with the Phileterian foot.

QUININE MANUFACTURE IN ITALY AND GERMANY.

The following account of the manufacture of sulphate of quinine in Italy, with suggestions as to the cultivation of the cinchona tree in the United States by Consul Crain, of Milan, is taken from the *Journal of Applied Science*. The manufacture of salts of quinine is an important Italian industry. It has been carried on at Milan and Genoa since 1870. Twenty-two thousand five hundred pounds are consumed yearly in Italy, of which one half is made at Milan, 6,750 lbs. at Genoa, and the balance imported from Germany. Forty-five thousand pounds of quinine and salts of quinine are produced in Italy. The production of the world is estimated at from 230,000 lbs. to 260,000 lbs. per year, as follows: — Germany, 56,250 lbs.; Italy, 45,000 lbs.; France, 40,000 lbs; England, 27,000 lbs.; America, 63,000 lbs.; India, 12,250 lbs. The two Italian factories produce 45,000 lbs. of the sulphate of quinine, viz., 40,500 lbs. at Milan, and 4,500 lbs. at Genoa. The first of these employs 45 hands, the second 15. The Milan factory ships largely to all parts, furnishing large supplies to Russia, France, and Austria. England receives two-thirds of her supply, and Holland one-half of hers from the same source. Efforts will be made to acclimatise the cinchona in Italy, to increase the supply and lessen the cost of the product. Its successful culture in India and Ceylon encourages the belief that it will grow wherever the soil is dry, the rainfall large, and climate temperate. Many parts of the United States fulfil these conditions, and notably where its product is needed. The culture of the cinchona in America would cheapen an indispensable medicine, and open a new industry to capital and labour. In this connection some facts reported by Mr. E. Van Eetvelde, the Consul-General of Belgium in India, are instructive. He reports that the best varieties of cinchona have been successfully acclimatised in British India. The Government there cultivate chiefly the *Cinchona succirubra*, which contains a large quantity of febrifuge alkaloids, and the *Cinchona calisaya*, which is better suited to the manufacture of quinine. The culture of the first has been successful. Uncertainty still exists as to the *Cinchona calisaya*, and the Bengal Government are examining the plantations of Java, where it has been cultivated with entire success. The cinchona plantations are in two distinct regions of India—in the north of the Neilgherry Hills, in the Madras Presidency, and on the slopes of the Himalayas. Those of the Government are as yet the most important, covering 1,300 acres on the Neilgherry Hills, and nearly 3,000 acres in Sikkim. There are several private plantations of later date already producing marketable bark. The red bark (*Cinchona succirubra*) has many febrifugal alkaloids, but little quinine. It was important, therefore, to determine the therapeutic value of the alkaloids and the cheapest means of extraction, in order to furnish a good febrifuge at a moderate price. The Medical Commission recommended the extraction of cinchonine, cinchonidine, and of quinine by simple means, and the Government now sells a mixture of these three alkaloids under the name of "Cinchona febrifuge." As the price does not exceed 2s. 7d. per oz., this febrifuge is used in nearly all the hospitals of India, and sold in large quantities to the public. The chief surgeon of the north-east province reports that the doctors are unanimous in declaring that the "Cinchona febrifuge" is a medicine of recognised efficiency in the treatment of ordinary intermittent fevers, and that it is an excellent prophylactic for those who live or travel in marshy countries. Most doctors are, however, of the opinion that it is inferior to quinine as a therapeutic agent, that its effect is slower, and that it is insufficient to cure severe intermittent fevers. That it is a medicine of value is shown by the increase in its use in the Indian hospitals, which, as the following figures show, is remarkable:—1874-75, 48 lbs.; 1875-76, 1,940 lbs.; 1876-77, 3,750 lbs.; 1877-78, 5,162 lbs.; 1878-79, 7,007 lbs. The hospitals took more than 5,500 lbs. in 1878-79, and, as the use of quinine diminished in the same time about as much, it is a proof, considering the cost of the last-named alkaloid, that the Indian Government saved about £25,000. At the present time the Government chemist of India is trying to produce a better febrifuge, by mixing three sulphates, viz., cinchonine, cinchonidine, and quinine, of which the cost would be a little higher. Financially, the plantations of Sikkim gave last year a net profit of nearly £4,000, although not fully developed, or 4½ per cent. on the sum invested.

From an official report recently published, it appears that within the German Empire there are five quinine manufactories, of which Prussia, Wurtemburg, Baden, Brunswick, and Hesse have one each. The most important German establishments are those of Zimmer, in Frankfort-on-the-Main; of Böhringen, in Mannheim; and of Jobst, in Stuttgart. The Zimmer establishment was founded by Dr. Conrad Zimmer, in the year 1837, and soon acquired considerable renown. It is now a very complete and extensive manufactory; it consumes about 50 bales of cinchona bark, and produce about 50 kilos. of quinine daily. The principal preparations of the German establishments are the sulphate and muriate of quinine. Of unbleached, or so-called hospital quinine, made from various alkaloids, they produce very little; while the cinchonidia sulphate is manufactured in large quantities, especially for export to the States. The efficacy of this drug is said to be similar to that of quinine, while its price is only one-third or one-fourth that of the sulphate of quinine. Amongst the numerous other salts and preparations of quinine made in Germany are chiefly to be mentioned the preparations of the amorphous quinines, especially the muriate. These preparations, being perfectly soluble, are much employed for injections in cases of fever resulting from wounds, and are therefore of particular importance to army hospitals. The German manufacturers get their cinchona bark mostly from London or Paris, which are the principal markets for that commodity. The bark is also brought extensively to Amsterdam from Java by the Dutch Government, and

of late years occasional lots have been imported at Bremen.

The Zimmer factory at Frankfort, two or three years ago, bought large territories in Java, and now employs about two hundred natives in clearing ground and planting cinchona.

BRITISH ASSOCIATION MUSEUM AT YORK.

The British Association for the Advancement of Science having decided to hold its annual meeting this year at York, where, fifty years ago, its first meeting was held, it has been thought that advantage should be taken of this jubilee meeting to show, as far as possible, the progress which has been made during the past half century in the construction of instruments of scientific research, and, with this view, it has been decided to invite men of science, scientific societies, and manufacturers, to exhibit, at the meeting, instruments of the latest patterns, and tools used in their construction; and if the science be fifty years old, the instruments used in 1831; otherwise specimens of the earliest patterns that can be found.

The proposed exhibition will also include apparatus and specimens illustrative of papers to be read at the Association meeting, which the authors may be willing to allow to be examined at leisure, as well as instruments constructed for the prosecution of special researches which have not yet become articles of ordinary commerce. It is very desirable that such instruments and apparatus should be exhibited in action, if arrangements can be made for the purpose.

The exhibition will be for the week of the meeting only, viz., from the 31st August to September 8th. To ensure that specimens entrusted for exhibition shall be as advantageously placed as possible, a special sub-committee, called "The Museum Sub-Committee," has been formed at York, who will afford every possible information.

Applications for space should be sent to the Hon. Secretaries, British Association Offices, 17, Blake-street, York, as early as practicable, but in any case not later than the 15th day of July, 1881.

ARTIFICIAL SEASONING OF TIMBER.

Mr. C. René, pianoforte manufacturer, of Stettin, Germany, as reported in *Engineering*, has devised a plan by which he utilises the property of oxygen, particularly of that ozonised by the electric current, to artificially season the timber used for the sounding-boards of musical instruments. The first impulse to experiments being carried out in this direction was given by the well-known fact that wood, which has been seasoned for years, is much more suitable for the manufacture of musical instruments than if used soon after it is thoroughly dried only. Mr. René claims that instruments made of wood which has been treated by his oxygen process possess a remarkably fine tone, which not only does not decrease with age, but as far as experience teaches, improves with age as does the tone of some famous old violins by Italian masters. We are further told that the sounding-boards made of wood prepared in this manner have the quality of retaining the sound longer and more powerfully. A number of pianos manufactured at Mr. René's works, and exported to the tropics several years ago, have stood exceedingly well, and seem in no way affected by the climatic dangers they are exposed to. While other methods of impregnating woods with chemicals generally have a deteriorating influence on the wood fibres, timber prepared by this method, which is really an artificial ageing, becomes harder and stronger. The process is, said to be regularly carried on at Mr. René's works, and the apparatus consists of a hermetically closed boiler or tank, in which the wood to be treated by the process is placed on iron gratings; in a retort, placed by the side of the boiler and connected to it by a pipe with stop-valve, oxygen is developed and admitted into the boiler through the valve. Provision is made in the boiler to ozonise the oxygen by means of an electric current, and the boiler is then gently fired and kept hot for forty-eight or fifty hours, after which time the process of preservation of wood is complete.

ACTINIC BALANCE.

Professor S. P. Langley, of the Alleghany Observatory, U.S., has devised a new instrument, which is said to be considerably more sensitive and accurate than the best thermo-pile, and which he terms an actinic balance. The principle of the apparatus is explained as follows:—A differential galvanometer, that is, a galvanometer with two equal coils of wire wound oppositely round the needle, has each coil connected in circuit with a strip of thin steel, and the same electric current is split up between them. If the resistances of the two steel strips are equal, the current will be divided into two halves, one half traversing one coil and the other half the other coil. These two currents will neutralise each other's influence on the needle, which will remain undisturbed. If, however, the temperature of one strip is raised above that of the other by exposure to a source of heat, the hotter strip will increase proportionately in its electric resistance, and the balance of currents on the needle will in turn be proportionally disturbed. The deflection of the needle will in fact indicate the change of temperature in the exposed strip. The strips employed by Professor Langley are thin steel bands $\frac{1}{500}$ millimetre thick, $\frac{1}{2}$ in. long, and $\frac{1}{20}$ in. wide, and several of them are placed side by side to get a broader surface exposed to the heat rays. As at present constructed, the instrument is said to be from 5 to 100 times as sensitive as the most sensitive thermo-pile, and its sensibility can be increased by coating the strips with lamp-black.

CORRESPONDENCE.

BAMBOO IN CEYLON.

In the discussion that took place after the reading of Sir Arthur Phayre's paper on British Burma, on the 13th May, I see that a quotation I read, bearing on the growth of bamboo, from the *Gardener's Chronicle*, of the 30th of April, is (inadvertently) omitted, referring to the Royal Botanical Gardens at Peradenya, Ceylon. H. J. E., a keen observer, writes:—

"Perhaps the most striking objects in these gardens are the extraordinary clumps of giant bamboo, which exceed anything I have ever seen or heard of. In some of them not less, and probably many more, than 200 culms of over 100 feet high are growing, as tightly packed together as possible. Some of the stems must be very nearly, if not quite, a foot in diameter, and the average, eight or nine inches. This splendid bamboo is, I believe, a native of the Malay Peninsula, and is the most remarkable instance of rapid growth I know of, each of these immense stems being formed in a few months."

To lovers of botany, a fine specimen of this bamboo may be seen at the Duke of Northumberland's garden, at Sion-house, Chiswick. I have a stem here from that clump, nearly 70 feet high, the top of which pushed its head through the roof of the conservatory.

Thomas Routledge.

Claxheugh, Sunderland, 30th May, 1881.

NOTES ON BOOKS.

New Commercial Plants and Drugs, No. 4. By Thomas Christy. London: Christy and Co. 1881.

Among the commercial plants described by Mr. Christy are the Ceara, the Mangablera, and the Apocynaceous rubbers, Landolphias, from Western Africa, and Chinese and Japanese peppermint plants. Chaulmugra oil, as a substitute for cod liver oil, varieties of bark, caroba leaves, Chian turpentine, and some plants already noticed in this *Journal*, are included under the head of new drugs. The descriptions of eleven new drugs from Japan, used for rheumatism, congestion, and many other diseases, conclude this part. One of them—mahng dah-rah-gay (*Datura alba*) is used by the natives of India for poisoning, and professional poisoners are often called dhatureas, on account of the use made of this drug.

Water-works Statistics, 1881. Edited by Charles W. Hastings. First issue. London. 1881.

An alphabetical list of towns is here given, with particulars in columns of source of supply, price, dividends, and other information. One hundred and thirty-four towns have made a return; 108 give source of supply, 131 state whether the supply is obtained by gravitation or pumping, 69 quantity raised per annum, 127 rental or assessment, 86 meter charge, 90 price per 1,000 gallons, 99 number of meters in use, 130 if constant or intermittent service, and 46 amount of dividend.

Gas-works Statistics, 1881. Edited by Charles W. Hastings. Third issue. London. 1881.

Returns from 726 towns in the United Kingdom are here given, which contain information respecting the number of tons of coal carbonised, the make of gas, illuminating power, price per thousand cubic feet, price paid for public lamps, and amount of dividend. About half the returns also give the illuminating power of the gas, and 200 the price realised for coke.

The Gas and Water Companies' Directory, 1881. Edited by Charles W. Hastings. Fifth issue. London. 1880.

This volume contains the dates of formation, the capital, the names of the engineers and secretaries of the companies, besides other information, and the population of the places, as well as their distance from London.

GENERAL NOTES.

Glass Making.—The following statistics relative to the manufacture of glass in the United States for the year ending May 31, 1880, compared with the results obtained by the census of 1870, is obtained from a preliminary report of the Census-office:—

	1880.	1870.
Number of establishments	194	154
Employes	23,822	15,367
	Dols.	Dols.
Capital	19,415,599	13,826,142
Wages paid	9,112,301	7,589,110
Materials used	7,991,303	5,904,365
Value of product	21,603,464	18,470,507

The investigation into the growth and extent of this industry included only those works which manufactured glass from the crude material, and not those in which manufactured glass is a raw material, such as manufactories of painted or stained glass, mirrors, chemists' ware, &c.

Colour of Seeds.—Mons. Pauchon has made a series of experiments with beans, on the influence of the colour of seeds on germination, with this result, that he finds in order to reach the same visible stage of development, a black or violet seed absorbs more oxygen than a white or yellow one, though a more rapid germination is observed in the latter. On the other hand, the quantities of carbonic acid exhaled by white seeds are found to be considerably greater than those from the dark, sometimes even double. These differences are considered to prove that dark or violet seeds are better conditioned from a physiological point of view. In the natural state, *i.e.*, when the seeds germinate in light—the conversion of legumin into asparagin must go on much more easily in the coloured seeds than in the others. "The more frequent and pronounced pigmentation of seeds of northern lands is, therefore," says M. Pauchon, "a favourable circumstance for the growth of these organisms, under the peculiar light-conditions to which they are subject."

MEETINGS FOR THE ENSUING WEEK.

Monday, June 6th. Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Geologists' Association, University College, W.C. Excursion to the Isle of Wight.

Tuesday, June 7th...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Morley, "Thomas Carlyle."

Biblical Archæology, 11, Hart-street, W.C., 8½ p.m. 1. Mr. Theo. G. Pinches, "Remarks on the Recent Discoveries of Mr. Rassam at Aboo-habba." 2. Dr. Birch, "Notes on the Recently-discovered Pyramid of Pepi at Sakkava. VI. Dynasty." 3. Prof. E. L. Lushington, "Description of Mentuhotap." 4. Mr. H. H. Howorth, "Was Piankhi a synonym for Sabako?"

Zoological, 11, Hanover-square, W., 8½ p.m.

Wednesday, June 8th.. Geological, Burlington-house, W., 8 p.m. 1. Prof. H. G. Seeley, "The Reptile Fauna of the Gosau Formation." 2. Prof. T. McK. Hughes, "The Basement-beds of the Cambrian in Anglesey." 3. Mr. J. S. Gardner, "Description and Correlation of the Bournemouth Beds." Part II. "Lower or Freshwater Series." 4. Mr. Robert F. Tomes, "Description of a New Species of Coral from the Middle Lias of Oxfordshire."

Microscopical, King's College, W.C., 8 p.m.

Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Thursday, June 9th...Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. E. Turner, "Russian Literature." (Lecture III.) "Tourgenieff."

Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.

Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Prof. Cayley, "The Gaussian Theory of Surfaces." 2. Prof. Genese, "System of Co-ordinates Disclosing an Extension of all Non-Metrical Properties of Conics to Circular Cubics and Bicircular Quartics with Collinear foci." 3. Mr. J. J. Walker, "A Theorem in the Calculus of Operations." 4. Mr. J. W. L. Glaisher, "Certain Symbolic Operators."

Friday, June 10th...Royal United Service Institution, Whitehall-yard, 3 p.m. Captain Walter James, "Military Education."

Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting. 9 p.m. Prof. Dewar, "Origin and Identity of Spectra."

Astronomical, Burlington-house, W., 8 p.m.

Quekett Microscopical Club, University College, W.C., 8 p.m.

New Shakspere, University College, W.C., 8 p.m. Mr. Poole, "The Alterations in the Acting Editions of Shakspere's Plays."

Saturday, June 11th...Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Prof. W. Chandler Roberts, "The Hardening of Steel." 2. Mr. W. Grant, "Curves of Electromagnetic Induction."

Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Prof. C. E. Turner, "Russian Literature." (Lecture V.) "Nekrasoff."

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FRIDAY, JUNE 10, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

MRS. BUCKTON'S LECTURE.

Preparatory to the Domestic Economy Congress, Mrs. Buckton, author of "Health in the House," will deliver, at the Royal Albert Hall, a lecture describing her method of teaching Domestic Economy at Leeds, with copious diagrams and illustrations, on Thursday, June 16th, at 11.30 a.m.

Tickets may be obtained on application to the Secretary of the Congress, Society of Arts, John-street, Adelphi.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, is now open daily. A non-transferable season ticket will be sent to any member of the Society on application to the Secretary.

PRACTICAL EXAMINATION IN VOCAL OR INSTRUMENTAL MUSIC.

The next Examination in London will be held by Dr. Hullah, the Society's Examiner, at the House of the Society of Arts, 18, John-street, Adelphi, W.C., during the week commencing on the 4th July, 1881.

HONOURS.

The Examination in Honours will consist of three sections, viz., a paper to be worked, an examination similar in form to the practical examination for a First and Second-class, and a *viva-voce* examination.

FIRST AND SECOND-CLASS.

Vocal.

Candidates for a First or Second-class Certificate in Vocal Music will be required—

[1.] To sing a solo, or to take part with another candidate in a duet, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, or successions of sounds or intervals, played or sung by the Examiner.

[3.] To sing or sol-fa at sight passages selected generally from classical music.

Instrumental.

Candidates for a First or Second-class Certificate in Instrumental Music will be required—

[1.] To play a short piece, or a portion of a larger work, already studied.

[2.] A key-note being sounded and named by the Examiner, the candidate to name sounds or intervals, played by the Examiner.

[3.] To play a piece or portion of a piece at sight.

The examination of each candidate will be private; no one but the Examiner and the accompanyist being present, unless it be a member of the Society of Arts' Committee.

No list of Candidates will be published.

Full particulars can be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CONVERSAZIONE.

The Society's *Conversazione* was held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Thursday, 2nd June.

The Galleries containing the Raphael Cartoons, the Sheepshanks Collection, the Wm. Smith Collection of Water Colour Drawings, the Dyce and Forster Pictures, the Collection of Paintings lent by the Trustees of the late Rev. Pryce Owen, and "The Chantrey Bequest," as well as the Courts and Corridors of the Ground Floors were open. The Reception was held in the Architectural Court, by Mr. F. J. BRAMWELL, F.R.S., Chairman, assisted by the following Vice-Presidents and Members of the Council:—Professor Abel, F.R.S., Mr. Brudenell Carter, Mr. B. Francis Cobb, Sir Philip Cunliffe Owen, K.C.M.G., Mr. W. H. Preece, F.R.S., Mr. Robert Rawlinson, C.B., and Mr. Owen Roberts.

A Promenade Concert was given by the String Band of the Royal Engineers (Conductor—Herr J. R. Sawerthal), in the North Court, the following being the programme of music performed:—

1. Overture	"Giralda"	Adam.
2. Selection	"Don Giovanni"	Mozart.
3. Musette	"Amors Küsse"	Morley.
4. Serenade	"Ständchen"	Schubert.
5. Fantasia	"Dinorah"	Meyerbeer.
6. Chor der Schaarwache		Gretry.
7. Selection	"Pirates of Penzance"	Sullivan.
8. Spanische Tänze (*a*) Moderato. (*b*) Bolero.		Moszkowski.
9. Waltz	"La Berceuse"	Waldteufel.
10. La Retraite Militaire		Lefévre.
11. Marche Romaine (Pius IX.)		Gounod.

Mr. Corney Grain gave an Entertainment in the Lecture Theatre, and Madame Frickenhaus' Pianoforte Recital was given in the Picture Gallery, the programme of the three parts of which was as follows:—

a. Etude, No. 3 *b.* Scherzo, Op. 20	Chopin.
a. Traumeswirren *b.* Einsame Blume *c.* Novelette, Op. 99	Schumann.
a. Capriccio (for the left hand)	Rheinberger.
b. Scherzo, from Sonata in A flat	Weber.
c. Tambourin	Raff.

The number of visitors attending the *Conversazione* was 2,710.

EFFORTS TO IMPROVE NATIVE HUSBANDRY IN SOUTH INDIA.

By Wm. Robertson.

In May, 1880, I had the honour to read before the Society of Arts a paper on "The State of Agriculture in South India." Since then the Indian Famine Commission report has been issued, and several important papers, embracing many of the subjects dealt with in my paper, have been read before this and other societies. Of course, on such questions some differences of opinion must exist, but, on the whole, the opinions expressed agree, generally, with those I ventured to place before you. My conclusions may be summarised regarding South India as follows:—

(a.) The good land is already under tillage; any addition made to the tillage area must therefore consist of inferior soils.

(b.) Additions made to the tillage area must be at the expense of the area that produces scrub-jungle and grass, which afford the ryot—free of cost—fuel for domestic use, and grazing for his stock, which resources thereby become lessened.

(c.) The addition of large areas of poor soils to the area under tillage, increases the necessity for applying manure, while the corresponding decrease in the area yielding fuel and grazing, diminishes the ryot's means of supplying this manure.

(d.) The proportion of the occupied area, cropped annually, is considerably greater now than at any previous period, thus the benefiting influences of "fallowing" are less exercised.

(e.) Half-tilled, unmanured, arable land, bare for six months in the year, is much less able to retain and store the rainfall than the land when under scrub-jungle; the rain-water flows more quickly off the land into the beds of streams, and the irrigation sources dry up sooner in the season.

(f.) There is, generally, a great waste of irrigation water; were the water used with care, the irrigable area might be largely increased.

(g.) Famines occur during long periods of drought, when the crops cannot obtain the water they require.

(h.) The half million persons added yearly to the population of the Presidency, rely for food chiefly on crops raised on inferior soils, farmed without the aid of irrigation water, and almost without manure.

(i.) Under present conditions, famines are likely to become more frequent and more severe.

(j.) Under good husbandry—by deeper tillage, and by the use of organic manures—the soils might be made much more fertile, and the crops rendered less liable to suffer injury during a moderate drought.

(k.) The welfare of the State depends upon the condition of agriculture, even to a greater extent now than formerly, seeing that it has guaranteed to protect the people against the effects of famine.

(l.) A primitive system of husbandry, which sufficed to meet the wants of a scanty population, when there was plenty of good land available, no longer suffices, now that the demand for human food has become so great, and such a large area of poor soil has to be tilled.

Early in the present century attention was given by the State to the improvement of indigenous varieties of cotton, but nothing on an extensive scale was attempted until about 40 years ago, when the Marquis of Tweeddale was Governor of Madras. A Cotton Department was then organised, and cotton farms were established in various parts of the Presidency. These so-called farms, I should explain, were mere tracks of land, frequently unfenced, and generally without any buildings. The land was devoted exclusively to the culture of cotton. On these farms, crops of Bourbon, Egyptian, and New Orleans cotton were grown from imported seed, and the seed produced was distributed over the Presidency; but the land was devoted chiefly to the culture of the better kinds of indigenous cotton, which, it was thought, might be improved by better culture, the liberal use of suitable manures, the careful selection of the best seed for sowing, &c. These farms were under the direct charge of men who had been brought from America, and who were supposed to possess a thorough knowledge of the cultivation of cotton, and its treatment when undergoing preparation for the market. In connection with these farms, experiments were carried on in ginning and packing cotton for export. These cotton farms were carried on for a short time in the face of many difficulties. Some valuable experiments were carried out, and much important information was collected. But a new Governor having been appointed, who had no interest in agriculture, the partially dormant opposition, which had existed for some time, assumed an active form, and the Cotton Department was eventually suppressed. There can be no doubt whatever that the administration of the department was defective in some important respects. But, taking into account the state of agricultural knowledge at that period, the many difficulties to be overcome, and the hostility of the class from whom aid and support might have been hoped for, the experiment was quite as successful as in reason could be expected. It was certainly a mistake to confine the operations of the farms exclusively to cotton culture. Had efforts been made on a similar scale, and with the same persistency, to improve agriculture generally, any improvement secured would have acted for good on cotton culture, and such results thus obtained would have been more lasting in their influence. It was also a decided mistake to import largely seed of superior varieties of cotton from countries where cotton is grown on fertile, almost virgin soils, or cultivated with skill by intelligent planters, and to attempt to introduce these kinds of cotton at once into general cultivation in South India, on impoverished, shallow-tilled, unmanured soils. Before superior sorts of cotton can be grown in South India with success, there must be a very great improvement in the character of the husbandry generally practised. In a few favoured localities, in various parts of the country, the conditions necessary for the successful culture of the higher races of the cotton plant can undoubtedly be secured; but the land thus favourably circumstanced is already usually fully utilised.

However, as I have already stated, the Cotton Department effected much good. We have, even now, in certain districts in South India, a variety of cotton introduced and acclimatised by the department, which, though much deteriorated,

is still superior to any indigenous cotton; while there can be no doubt that the immense quantity of superior cotton seed distributed over the country has effected much good in indigenous cotton, by interbreeding with it.

The plea under which the Cotton Department was suppressed, was that the department was not a financial success—that its income did not meet its expenses; as if this was the standard by which the results of the operations conducted were to be judged. I never can understand why in India this standard should be applied only to enterprises having for their object the improvement of agriculture. Were the same standard applied to the results of the working of the various departments of the State, in determining the claim of these departments for continued existence, I fear they would have no better ground to exist longer than had the defunct Cotton Department; while, in this country, that great institution, the South Kensington Museum, which is doing so much for the education of the British public, the equally important institution at Kew, would have to be suppressed were their results judged of by this shop-keeping standard. It is true that the outcome of all successful agricultural enterprise must, of necessity, be a gain, but it does not follow that this gain can be made to assume a money form for the State.

Of the many difficulties encountered in conducting the work of the Cotton Department, not the least was the suspicion with which its operations were viewed by the ryots generally. They could not imagine it possible that a Government, apparently influenced only by ordinary commercial policy, could act, as it were, disinterestedly. In many instances they not only refused the use of their land for the experiments, though a liberal money compensation was offered, but not unfrequently refused to accept, for sowing, superior cotton seed when offered free of all charge. They seemed firmly to believe that the sole object of Government in giving attention to cotton culture, was to get a reason for raising the rent of the land.

After the closing of the Cotton Department, the State withdrew from all active interference in cotton cultivation, and, for some years, but little was done by the State in any other direction towards agricultural improvement. A few isolated experiments were conducted here and there under district collectors, notably the late Mr. John Sullivan, who, in the Coimbatore Collectorate, conducted many useful agricultural experiments, chiefly in the introduction of new crops on the Nilgiris, then constituting a portion of the Coimbatore district. Amongst other crops he introduced there, was a variety of wheat obtained from South Italy, which at one time was largely cultivated on these hills, and, even now, is grown to some extent there. This gentleman also introduced barley, and several crops now well established on the Nilgiri Hills. But, generally, the experiments conducted by collectors at this period seldom yielded results of a useful nature, not so much from want of knowledge or want of interest on the part of collectors, but from want of leisure to give the experiments the required attention, and from the frequency with which they were transferred to other collectorates.

Agricultural shows have been held in various parts of South India, with a view to the promotion of agricultural improvement. About twenty-five years ago, shows of this nature were frequently held in the different districts. At these shows prizes were offered for good specimens of agricultural stock, field produce, agricultural implements, tools, &c. The shows were held at the head-quarters of the collectorates. The prizes were numerous, but small in amount. The average cost of such a show was about £200, the whole of which was provided by Government. In the districts of South India, among a people so backward as are the rural classes there, generally, the holding of agricultural shows could not but be attended with advantage. But the shows were, at first, undoubtedly looked upon with great suspicion by the agricultural classes. The Revenue Board of the Presidency, in referring to one of these provincial shows observed, "The committee at Cuddapah had great difficulties to contend with, and experienced considerable opposition. The show, therefore, can be regarded as having effected little more than dissipated the suspicions and fears of the people." Afterwards, in referring to the results of the first series of these shows, the Board remarked, "The provincial exhibitions, generally, have been as successful as, under all circumstances, could have been expected." About three or four years later (1859), a number of provincial agricultural shows were again held in Madras, fifteen having been held in that year, at a cost of about 35,000 rupees. The results of these shows, appeared to have been considered disappointing, for the Board of Revenue, who again had the control and general management of the shows, thus wrote:—

"On the present occasion, long notice was given, and full publicity ensured. The sum placed by Government at the disposal of the local committees was ample, and liberal prizes were offered for competition. The Board regret, however, to state that, with few exceptions, the result has not been satisfactory. The novelty of the thing has, to a great extent, worn off; the preconceived idea, of the majority of the exhibitors, apparently, that the trouble of producing a specimen was in all cases deserving of reward, without reference to the character of the article, and their corresponding disappointment, the depreciating accounts of unsuccessful competitors, the fear of cholera, and, in some instances, the superstitious belief that the unfavourable seasons of late years were to some extent produced by the 'evil eye' of those to whom the produce of their labours was publicly exhibited, have combined to produce this result. The interest, however, of the spectators seems to have been unabated, and that good has resulted from the movement the Board believe. The cultivation of valuable special products has been extended, and in some cases originated—improvements in farming, in cattle breeding, and in implements, have been encouraged, and some acquaintance with the advantages of machinery afforded. Some branches of manufacture, which promise to be valuable, have been developed, especially in fibres, and it may confidently be expected that the seeds of emulation and enterprise that have been sown will bear fruit in the future."

If the results mentioned in the latter part of this quotation were really as stated, I venture to think that these provincial shows were successful, and that they ought to have been continued from year to year.

During the last 20 years, but very little has been done in holding agricultural shows. Two have

been held near the City of Madras, and one on the Nilgiris, and one or two in other districts; but none since 1874. In one district, that of Nellore, cattle shows were held for several years in succession; but these also have been discontinued. At the present time, therefore, this highly important means of improving agriculture is altogether unemployed in South India.

In England, with its highly advanced agriculture, we have in every county an agricultural association, and in many counties several district or local agricultural societies, all actively at work in promoting agricultural progress. These associations and societies in the British isles spend annually very little less than half a million pounds sterling; an expenditure which, I think, can be justified on strictly commercial principles, and yet, according to the present Indian official view, such an expenditure would be considered unjustifiable. I am strongly of opinion that agricultural shows should be held annually in every district of South India. The cost would be but trifling compared with the vast revenue the land yields the State, and I am confident that eventually satisfactory results would be secured. For a time we must be content to sow, feeling assured that, if proper means are taken, a harvest of good results will certainly follow. Agriculturists are slow everywhere in adopting improvements. It is unfortunate that, in dealing with the great question of agricultural reform in India, narrow-minded, unintelligent views have been allowed to crush the germs of reform. The matter must be viewed from the same standpoint as ordinary educational efforts. If the expenditure of £100,000 a year on literary education in South India is justifiable, surely the expenditure of a few thousand pounds annually over that country, in promoting the material interest of the classes amongst whom we are so anxious to create M.A.'s and B.A.'s is, to say the least, equally justifiable. But, then, our land administrators are "classical scholars," not agriculturists, and their panacea for the deplorable state of the agricultural classes—and, let it be remembered, India is essentially an agricultural country—is education in Greek and Latin.

When Sir William Denison became Governor of Madras, attention was again directed to agricultural improvement, and this was kept up until Lord Napier, who succeeded Sir William Denison, ceased to be the Governor of the Presidency. A large number of agricultural implements and machines were then purchased in this country, but, when they arrived in India, it was found that they could not be worked under suitable conditions, Government then having no suitable land under its direct control on which the machines could be worked. The necessity for testing these machines, &c., under proper superintendence, suggested to the authorities in 1865, the propriety of establishing a Government farm; and a piece of land of about 300 acres, situated about six miles to the south of Madras, which was then covered by a prickly-pear jungle, was selected as the site of the farm. The selection was made because the land was the property of Government, and because the medical authorities had declared that it was absolutely necessary to clear the land, as in its then state it was the cause of much fever in the neighbouring town of Saidapet. A committee of Government officials was appointed to manage the farm. At first, operations were confined to clearing a few acres of land, sufficient to afford opportunities for trying field implements, chiefly light ploughs. For some years after opening the farm, but little was done beyond clearing the prickly-pear jungle, laying out the land in fields, making roads, and erecting cattle-sheds. The committee got together some useful varieties of farm stock, and conducted several small experiments in growing new crops. But their attention was chiefly confined to implements, of which they imported several useful kinds. At this period of the farm's existence, the chief aim of its conductors was simply to show that European implements of a suitable kind, could be worked with success by the cattle of the country. They also gave attention to water-lifts, of which they purchased and erected several of different kinds for experimental trials.

In 1871, this committee was abolished, and the general control of the farm was given over to the Presidency Board of Revenue. It was then proposed that the farm at Saidapet should be a central experimental station, with branch experimental stations in each district of the Presidency, the whole to be conducted by a small department, then organised, with head-quarters at Saidapet. The objects to be kept in view by the department were specified by Government to be as follows:—

(1.) To ascertain, by experiment, the proper use of rotation in crops in this country.

(2.) To introduce the system of root or green crops, in lieu of fallow, without artificial irrigation.

(3.) To introduce new crops.

(4.) To provide new kinds of seed; and fresh seed for the crops now cultivated.

(5.) To make experiments in the use of water for the cultivation of crops now termed "dry" crops, and for raising grasses and other crops to be used as fodder.

(6.) To make experiments in the use of lime and other manures, mineral and animal.

(7.) To introduce new and improved implements of rural labour.

(8.) To improve the working cattle, sheep, horses, and other varieties of live stock in the country.

These objects have been steadily kept in view in the management of the department, as far as its very limited means permitted, or as the controlling authorities would allow.

The first difficulty that presented itself in attempting to carry out the scheme was, the absence of qualified natives, who alone were to be placed in charge of the district stations. To meet this difficulty, Government authorised the entertainment, at Saidapet, of a number of youths, who were to be trained there, for employment afterwards as superintendents of these stations. These youths were to become qualified for their difficult duties merely by taking part in the ordinary operations of the farm. Though liberal stipends were offered, and promises were held out of future employment on liberal salaries, no well educated youth, of the stamp required, could be induced to join this apprentice class. The fact was, as agriculture was at that time known to the people generally, it was estimated a pursuit only fitted for the unintelligent portion of the community. A

class was formed of the sons of subordinate officials and others, who duly appreciated the high stipends (Rs. 40 per month) offered, but it was soon ascertained that mere field-training would never fit men of the sort forming the class to hold the responsible position of superintendents of experimental stations. After a very full trial, the fact was recognised—a fact well known before to those acquainted with the subject—that in order to provide qualified native superintendents for the district experimental stations, it was absolutely necessary to secure well educated youths, and to subject them to a prolonged training of a systematic kind. In this view, the Revenue Board of that day fully concurred, as the following extract from one of their published proceedings shows:—

"(1.) That unless systematic instruction in agriculture and the sciences bearing on it is given at the Saidapet farm, competent superintendents for the experimental farms, which are to be instituted, cannot be trained there.

"(2.) That without superintendents trained in this way, the experimental farms will be of little or no use.

"(3.) That the means for giving such a training, the lecturers, the students, and the opportunities for practising what is taught, and the funds, are all available.

"(4.) That the good effects of the instruction will not be limited to a few superintendents of Government farms, but will slowly leaven the agriculture of the whole country, as in England, America, France, and Germany.

"(5.) That as a scene of systematic instruction open to all comers, the Saidapet farm will be infinitely more useful to the public than it is at present."

It was only after a great expenditure of time and effort in discussing the question, that a reluctant consent was obtained for the establishment of an agricultural college, on a small scale, at Saidapet, in which youths could be trained for employment, as superintendents of district experimental stations, and agricultural instructors; for private employment, &c. A comprehensive scheme was organised, and its details extensively published in the form of a prospectus. Though the institution was originated in view to train district farm superintendents, &c., no inducements of any kinds were held out of State employment for those who passed successfully through the institution. Indeed, there was a nervous anxiety at the time that every candidate should clearly understand that, in qualifying as an agriculturist in the institution, he would thereby establish no claim whatever on Government. In connection with the institution, 24 bursaries were established, each worth about £15 a year, and tenable during 2½ years of the three years of training. These bursaries could only be got and retained by really industrious students, after six months attendance at the college, and who continued during their whole course of training to keep up to the standard of progress laid down. A high minimum of marks was to be gained at each of the twenty or more examinations of each session, while evidence of a thorough practical acquaintance with the working of ploughs and other field implements was insisted on.

After a sufficient time had elapsed to allow of the thorough publication of the prospectus, and for a full discussion in the native press of the objects and nature of the new institution, applications from would-be candidates began to be received in considerable numbers, and from nearly all parts of India. No candidate was accepted who had not qualified in the educational standard prescribed for ordinary State employment, or for proceeding to a University degree, or who failed to pass the special (equally difficult) entrance examination of the college. All candidates had to produce medical certificates of physical fitness for active employment, certificates of character, &c., and each candidate selected was between the ages of 18 and 24.

Notwithstanding the previous repeated failures in filling the apprentice classes, when such substantial advantages were offered, there was no difficulty now in securing any number of qualified, educated youths. The institution began work in 1876, with a first class, in temporary sheds. The erection of commodious but unpretentious buildings was sanctioned, in which to carry on the work of the institution. The permanent accommodation was to consist of lecture-rooms, class-rooms, a reading-room, and a library; and separate buildings were to provide accommodation for a veterinary hospital and a chemical laboratory; while, in addition to the farm, botanical grounds were to be established; but only the chemical laboratory has yet been erected. The nature of the training afforded by the institution, will be gathered from the following extracts from the college prospectus:—

"The instruction given in the institution will embrace a thorough study of agriculture, and of such portions of chemistry, geology, zoology, botany, and the veterinary art as bear on the theory and practice of agriculture. In addition to these special subjects, the following will also receive attention:—Farm book-keeping, land surveying, mensuration, and drawing. The instruction will be given by means of lectures, class-room discussions, and field classes.

"During the portion of the day set apart for practical instruction in farming out of doors, every student will be expected to take part in whatever work is going forward on the farm; compliance with this regulation will be strictly enforced. Each student will be expected to make himself acquainted with all the operations daily performed on the farm, and will be required to keep a journal or diary of the same."

In 1878, a second class was formed, and applications for admission into it were even more numerous than they were for admission into the first class. That there was a widespread demand for agricultural instruction was amply evident.

In reviewing the work of the institution at this period, after it had been at work for nearly three years, the Government of the Presidency, in a published order, stated, "the progress and working of the institution have, on the whole, been very satisfactory."

A change of policy, however, took place at about this time in the treatment of the institution, partly under the influence of the general State policy of reduction of expenditure, from which that department suffered. And of the twenty-four bursaries attached to the institution, nine were then suppressed, and these were afterwards reduced to five only in a class; while the value of the bursaries was reduced from about £12 to £8 per annum. The entire saving to the State by these reductions would amount to only about £100 a-year; but the effect, combined with other causes, was highly injurious to the institu-

tion, for, when it was again attempted to form a new class, only seven eligible candidates were secured.

The practice of paying stipends, or bursaries, to youths undergoing special training, is almost universal in India, in the Medical, Forest, Educational, and Engineering Departments. Very few students from the agricultural districts can afford the expense of journeys, frequently long, and the cost of maintenance away from their homes, during a three years' college course. The provision of bursaries to aid indigent able students, is as necessary, to say the least, in South India, as in Scotland, Ireland, or England. A time may, it is hoped, arrive when agricultural education in India may not require to be aided in this way; but as long as such aid is necessary in every civilised country, it surely was premature to withdraw such aid from the but recently started agricultural institution in Madras.

Only one class of students has completed the full period of training in the Madras College. Of these young men, the majority are filling agricultural situations, and generally with credit; eight of them are employed as agricultural instructors in the Bombay Presidency; but, in Madras, none of the graduates of the college have yet been employed by Government, though there were several well fitted, after undergoing a little special training for the posts of agricultural instructors, and for superintendents of experimental stations, the establishment of which has been deferred so long from the impracticability of previously getting qualified native superintendents.

(*To be continued.*)

MISCELLANEOUS.

XANTHORRHŒA RESINS.

A paper was read by Mr. J. M. Maisch on these resins, at the Philadelphia Pharmaceutical meeting of April 19th last, which is reported in the *American Journal of Pharmacy*. The author, after having seen a resin exhibited as a new Australian product, under the name of Gum acroides, discovered that the supposed new commercial article had been known in the United States for upwards of 25 years, and was, in fact, identical with Botany Bay resin.

"The genus *Xanthorrhœa* belongs to the natural order of *Liliaceæ*, is confined to Australia, and consists of shrubby, or arborescent plants, somewhat palm-like in appearance, and having at the summit dense tufts of very long, wiry, narrow, two-edged, or somewhat triangular, leaves, resembling grass leaves; hence the name *grass-trees*, by which the species are known in Australia. The leaves are used as fodder for cattle, and the somewhat sheathing base of the inner leaves and the buds are eatable, and form, particularly when roasted, an agreeable article of food. From the centre of the leaf tuft, there rises a long cylindrical scape, which terminates with a long spike of small white flowers, situated in the axils of the imbricate bracts, and producing triangular three-celled capsules, containing flattish, hard, black seeds.

"R. Brown (1801) described seven species, viz., *X. arborea*, *australis*, *hastilis*, *media*, *minor*, *bracteata*, and *pumilio*. The two first-named species are arborescent, while the third and fourth have short stems, that of *X. hastilis* being about 4 feet high, and is said to sometimes attain a diameter of 1 foot, and then to be probably more than a century old, owing to its slow growth. The last three species named before are stemless, *i.e.*, the stems remain buried in the soil or rise scarcely above ground.

"All the species abound in a resinous juice, which, on exposure, hardens, and as obtained from the different species, undoubtedly differs in appearance and also in composition. Guibourt distinguishes three xanthorrhœa resins—one yellow, one brown, and one red. The dark-coloured resin is still ascribed by some authors to *X. hastilis*, but Drummond (1840) pointed out that an arborescent species, probably *X. arborea*, is in Australia called 'black boy,' and the Pharmaceutical Society of Victoria state that *X. australis* (which is arborescent) yields a large quantity of a brilliant ruby-coloured resin. On the other hand, the botanist Smith refers the yellow resin to *X. hastilis* and some other species. The last named is the *X. resinosa* of Persoon, and of it *Acaroides resinifera* is quoted as a synonym in Gray's 'Supplement.' The name acaroid resin is thus explained. The different xanthorrhœa resins have been described more especially in regard to their uses in papers by Mr. Redford, as a polishing material, in *American Journal of Pharmacy*, 1863, p. 453, 454, and by Mr. P. L. Simmonds, in the same journal, 1857, p. 226 to 228, and in 1866, p. 465 to 468; the papers last quoted refer chiefly to the use of the resin in the manufacture of illuminating gas. The resins seem to be obtained as natural exudations, the subterraneous portions of the plant producing them in some species, at least, apparently in great abundance; but resin is also found covering the base of the leaves, and it is secreted in such quantity in the woody stems that, after crushing the latter, it may be sifted from the chips to the extent of a hundredweight per diem by one labourer.

"The acaroid resin, which was first noticed in 1789, by Governor Phillip ('Voyage to Botany Bay') is met with in tears and in large masses usually, on account of its brittleness, broken into irregular pieces. It is intermixed with portions of wood, stalks, earth, &c., and when fractured has a speckled or granitic character. The pure resin is reddish yellow; the commercial article is externally brownish yellow, and internally opaque and of a pure yellow colour, resembling that of gamboge, but always much lighter. This colour description by Guibourt agrees with the sample presented here; but since the resin is described by some authors as being of a deeper yellow than gamboge, it is evident that it must be sometimes collected from different species. Triturated with water it does not form an emulsion. When fresh it has an odour analogous to that of poplar buds, but much more agreeable (Guibourt); the odour appears to approach very nearly that of benzoin mixed with a little storax. By age the odour becomes weaker, and gradually disappears, but it is always developed on powdering or by fusion. The resin dissolves in alcohol, leaving only 0·07 of a gum insoluble in water and analogous to bassorin. When heated it gives off white vapours, condensing into brilliant small laminæ, which Laugier regarded as benzoic acid, but which Stenhouse (1848) found to consist largely of cinnamic acid.

"The brown resin has a more balsamic odour than the preceding; the tears are roundish, externally deep red-brown, and resembling dragon's blood; but the fracture is shining, glass-like, and in thin splinters it is perfectly transparent, and of a hyacinth-red colour. It is completely soluble in alcohol, and contains more volatile oil, rendering it viscous and somewhat adhesive.

"The red resin is in distinct tears of a deep brown-red, and sometimes externally bright red; its fracture is glass-like; thin splinters are transparent, and ruby-red; it is completely soluble in alcohol, the ligneous intermixtures excepted, and its balsamic odour becomes always apparent on heating.

"Regarding the composition of the xanthorrhœa resins, Pereira quotes the analysis of Lichtenstein (1799), Schrader, Laugier, Wiedemann (1825), Trommsdorff (1826), and Stenhouse (1848). Heated with manganic binoxide and sulphuric acid, acaroid resin evolves the odour of oil of bitter almonds, and by the action of nitric acid it yields a large proportion of carbazotic (picric) acid with little nitrobenzoic and oxalic acid (Stenhouse). Trommsdorff found the volatile oil to be colourless, fragrant, and of a pungent aromatic taste. The resin is soluble in solutions of the alkalies and alkaline earths. On dry distillation much carbolic acid is obtained, with a small quantity of a light oil, but, according to Sommer, no umbelliferon. In 1866, Hlasiwetz and Barth ascertained that acaroid resin on being treated with fusing potassa yields large quantities of paraoxybenzoic acid, and from the mother-liquor of the ethereal solution a little resorcin and pyrocatechin was obtained, together with the double compound of protocatechuic and paraoxybenzoic acids = $C_{14}H_{12}O_7.2H_2O$, which had been previously obtained from benzoin.

"Three different xanthorrhœa resins were found by Hirschsohn (1877) to be incompletely soluble in chloroform and ether, but to dissolve completely in alcohol, the solutions acquiring a brown-black colour with ferric chloride. The solution of the acaroid resin is yellow, and yields with lead acetate a precipitate, while the solutions of the other two resins are red, that of *X. quadrangulare* being not disturbed by acetate of lead, while that of *X. arborea* produces with the same reagent a turbidity; the chloroformic solution of the latter is yellow, that of the former colourless.

"The xanthorrhœa resins have been repeatedly suggested as possessing some value in perfumery; but they appear to be inferior for this purpose to benzoin, storax, and the balsams of Peru and Tolu. Their medicinal properties appear to be likewise not well marked. As early as 1795, experiments were made on acaroid resin, for the purpose of learning their properties. Dr. Fish (*Boston Journal*, x., p. 94) employed it in the form of tincture, with opium, in phthisis, and it has been recommended in chronic catarrhs. A tincture of acaroid resin, mixed with milk or a mucilaginous liquid, has been recommended to be made of equal weights of the resin and alcohol."

VEGETATION OF THE AUSTRALIAN DESERT.

A report on the geological and zoological features of the central parts of South Australia, by Mr. E. B. Sanger, has been lately issued, from which the following is quoted in *Colonies and India*, showing that there has hitherto been considerable misapprehension as to the so-called "Great Australian Desert":—

"From the Gums to Manuwaukaninna the country consists of stony tablelands, alternating with alluvial plains. The borders of the tablelands are generally higher than the central portions; thus, when seen from the plains, they assume the appearance of low flat-topped hills. Each plain is intersected by one or more watercourses, dry for the greater part of the year, or at any rate drying up into a few waterholes. The watercourses have a general westerly flow, and after a certain distance either run out altogether or expand into a flood-flat, or, as it is called, a lake; one or two of the largest are said to empty into Lake Eyre. When the rainy season sets in, or even after a heavy shower, they rapidly fill, and, overflowing their banks, spread over the flood-flats, forming the so-called 'lakes.' The flood-water gradually drains away, leaving the flats again bare. Some, however, of the flats, being situated at a lower level than the others, have water over them all the year round, as, for example, Lake Harry. When the rainfall has been *nil*, or, at least, very small, for two or three successive seasons, as is often the case, these last-named lakes soon grow salt and unfit for drinking. This is explained by the fact that the flood-waters wash out from the rocks and hold in solution a large percentage of the chlorides, carbonates, and sulphates of sodium, calcium, and magnesium. Accordingly, when the water is spread out over a large surface, as on the flood-flats, evaporation takes place very rapidly, until concentration occurs to such a degree that the water is unfit for use. When, however, a new flood comes down or a heavy rain occurs, the lakes assume their pristine freshness. The most interesting feature of the tableland country to a geologist is the enormous effect of denudation. Every flood brings down a vast amount of detritus, and deposits it over the plains. In some places the alluvial deposits attain a thickness of 50 or 60 feet. On the tablelands the destructive effects of denudation are seen better still. One cannot but be surprised when one looks over the immense heaps of water-worn stones lying everywhere, and forming a talus to every cliff, and reflects upon the apparently small causes that have been able to produce such large results. One is necessarily impressed with the vast amount of time it must have taken.

"On the tablelands vegetation is comparatively poor, consisting of stunted shrubs and trees. But, desolate as it appears, after rain grass springs up with amazing rapidity, and what a short time before was a desert of stones, become clothed in a garment of brilliant green. It is, however, on the rich alluvial plains that the vegetation is the most luxuriant and the best pasture found. North of Manuwaukaninna the appearance of the country changes completely. The stony tablelands disappear, and in their place low ridges of dazzling white sandhills stretch away for hundreds of miles to the north and west. Here commences what has been called the Central Desert of Australia. The term desert, however, should be used with caution. No one seeing the sandhill country after a heavy rain would venture to call it a desert. It must be admitted, however, that during the long periods of drought it is indeed but little more than a second edition of Sahara. It is owing to the great difference in the appearance of the country in the wet season and its aspect in the dry season, that discrepancies have arisen between the reports of persons who have explored the region. Some have described the interior as a veritable desert, and others as a magnificent country, peculiarly adapted to pasture.

"The sandhills have a general north and south trend. A peculiarity worthy of note, and which will be explained further on, is that the western sides are invariably sloping and the eastern sides abrupt. Between the sandhills are flood-flats, similar to those we have described as alternating with the stony tablelands, and, like the latter, are periodically flooded by the overflowing of the creeks that wind through them. The flood-water is generally not of local origin, as in the tableland country, but is the result of heavy rains in the tropics far to the north. The surplus flood-water from the tropics backs down the Cooper, Diamantina, and the network of watercourses which connect them, and ramify through the country, and slowly fills the lakes and flood-flats. This happens, to a certain extent, every year. The Cooper and other creeks are then said to 'run.' This overflow of tropical rains reaches annually as far down the Cooper as Coongie, but it is only an exceptional flood that causes the Cooper to run below Coongie and fill the large lakes between there and Manuwaukaninna—*i.e.*, Lake Hope, Lake Perigundi, and Lake McKinlay. As a matter of course, in seasons of prolonged drought, the above-mentioned lakes become salt. Occasionally heavy local rains freshen the water of the lakes and fill the waterholes in the creeks, but never, as far as I am able to ascertain, cause a flood. The alluvial deposits necessarily differ in character from those of the tableland

country. The former are composed for the most part of a red gritty clay, while the latter are stiff blue marls. These two clays may be said, to a certain extent, to be characteristic of the two regions. Where the red gritty clay is found, the old palæozoic rocks may be looked for. The blue freshwater marl is only met with in the sandhill country. The explanation of this difference is at once apparent when the nature of the rocks from whence the alluvium is derived is examined. On the one hand it is derived from schistose, slaty and porphyrytic rocks, with veins of black oxide of iron, which last when washed out by the water oxidises, forming the red oxide of iron which gives the alluvium its red colour; on the other hand it is derived from the tertiary sand and limestones, and mixed with a large amount of decaying vegetation. We have spoken of the arrangement of the sandhills in parallel ridges having a north and south trend, and also of the sloping character of the western side and the abruptness of the eastern side. These facts will serve to throw some light upon the origin of sandhills. After any windy day, if we look at a stretch of land where the wind has had free access, it will be found that the sand is thrown into series of small ridges or ripples, whose long axes are transverse to the direction from which the wind blows. On examining them closer it will be seen that the side towards the wind is sloping, and the opposite side abrupt. Here again, we have in miniature the whole sandhill country. Now, the same cause that made the land ripples has made the hills, and that is the wind. In the one case it took a day, in the other it has taken many centuries, to produce the result. The prevailing winds throughout the region are westerly, and, as we should expect, the sandhills tend north and south. And, again, the sloping side of the sandhills face towards the wind. The sandhills of the country, in fact, indicate the direction of the prevailing wind. No fact is impressed more strongly upon a geologist than this—that it is with comparatively small means that nature produces the greatest results. Whether it is the upheaval of the Alps, or the subsidence of the coral basin of the Pacific, the levelling of mountain ranges or the filling-in of ocean basins, in all apparently small causes produce the result—in all the same grand impassive uniformity is displayed."

FAURE'S SECONDARY BATTERY.

Sir William Thomson, F.R.S., has written the following letter to the *Times*, containing the results of his experiments with Mons. Faure's battery, described in the *Journal* of May 20th (p. 576):—

The marvellous "box of electricity" described in a letter to you, which was published in the *Times* of May 16th, has been subjected to a variety of trials and measurements in my laboratory for three weeks, and I think it may interest your readers to learn that the results show your correspondent to have been by no means too enthusiastic as to its great practical value. I am continuing my experiments to learn the behaviour of the Faure battery in varied circumstances, and to do what I can towards finding the best way of arranging it for the different kinds of service to which it is to be applied. At the request of the Conseil d'Administration of the Société de la Force et la Lumière, I have gladly undertaken this work, because the subject is one in which I feel intensely interested, seeing in it a realisation of the most ardently and unceasingly felt scientific aspiration of my life—an aspiration which I scarcely dared to expect or to hope to live to see realised.

The problem of converting energy into a preservable and storable form, and of laying it up in store conveniently for allowing it to be used at any time when wanted, is one of the most interesting and important in the whole range of science. It is solved on a small scale in winding up a watch, in drawing a bow, in compressing air into the receiver of an air-gun or of a Whitehead torpedo, in winding up the weights of a clock or other machine driven by weights, and in pumping up water to a height by a windmill (or otherwise, as in Sir William Armstrong's hydraulic accumulator) for the purpose of using it afterwards to do work by a waterwheel or water pressure on a piston. It is solved on a large scale by the application of burning fuel to smelt zinc, to be afterwards used to give electric light or to drive an electro-magnetic engine, by becoming, as it were, unsmelted in a voltaic battery. Ever since Joule, 40 years ago, founded the thermodynamic theory of the voltaic battery and the electro-magnetic engine, the idea of applying the engine to work the battery backwards, and thus restore the chemical energy to the materials, so that they may again act voltaicly, and again and again, has been familiar in science. But with all ordinary forms of voltaic battery the realisation of the idea to any purpose seemed hopelessly distant. By Planté's admirable discovery of the lead and peroxide of lead voltaic battery, alluded to by your correspondent, an important advance towards the desired object was made 20 years ago; and now by M. Faure's improvement practical fruition is attained.

The "million of foot pounds" kept in the box during its 72 hours' journey from Paris to Glasgow was no exaggeration. One of the four cells, after being discharged, was recharged again by its own laboratory battery, and then left to itself absolutely undisturbed for ten days. After that it yielded to me 260,000 foot pounds (or a little more than a quarter of a million). This not only confirms M. Reynier's measurements, on the faith of which your correspondent's statement was made; it seems further to show that the waste of the stored energy by time is not great, and that for days or weeks, at all events, it may not be of practical moment. This, however, is a question which can only be answered by careful observations and measurements carried on for a much longer time than I have hitherto had for investigating the Faure battery. I have already ascertained enough regarding its qualities to make it quite certain that it solves the problem of storing electric energy in a manner and on a scale useful for many important practical applications. It has already had in this country one interesting application, of the smallest in respect to dynamical energy used, but not of the smallest in respect to beneficence, of all that may be expected of it. A few days ago my colleague, Professor George Buchanan, carried away from my laboratory one of the lead cells (weighing about 18 lb.) in his carriage, and by it ignited the thick platinum wire of a galvanic *écraseur*, and bloodlessly removed a nævoid tumour from the tongue of a young boy in about a minute of time. The operation would have occupied over ten minutes if performed by the ordinary chain *écraseur*, as it must have been had the Faure cell not been available, because in the circumstances the surgical electrician, with his paraphernalia of voltaic battery to be set up beforehand, would not have been practically admissible.

The largest useful application waiting just now for the Faure battery—and it is to be hoped that the very *minimum* of time will be allowed to pass till the battery is supplied for this application—is to do for the electric light what a water cistern in a house does for an inconsistent water supply. A little battery of seven of the boxes described by your correspondent suffices to give the incandescence in Swan or Edison lights to the extent of 100 candles for six hours, without any perceptible diminution of brilliancy. Thus, instead of needing a gas-engine or steam-engine to be kept at work as long as the light is wanted, with the liability of the light failing at any moment through the slipping of a belt—an accident of too frequent occurrence—or any other breakdown or stoppage of the machinery, and instead of the wasteful inactivity during the hours of day or night when the light

is not required, the engine may be kept going all day and stopped at night, or it may be kept going day and night, which will undoubtedly be the most economical plan when the electric light comes into general enough use. The Faure accumulator, always kept charged from the engine by the house-supply wire, with a proper automatic stop to check the supply when the accumulator is full, will be always ready at any hour of the day or night to give whatever light is required. Precisely the same advantages in respect of force will be gained by the accumulator when the electric town-supply is, as it surely will be before many years pass, regularly used for turning lathes and other machinery in workshops and sewing machines in private houses.

Another very important application of the accumulator is for the electric lighting of steamships. A dynamo-electric machine of very moderate magnitude and expense, driven by a belt from a drum on the main shaft, working through the 24 hours, will keep a Faure accumulator full; and thus, notwithstanding irregularities of the speed of the engine at sea, or occasional stoppages, the supply of electricity will always be ready to feed Swan or Edison lamps in the engine-room and cabins, or arc lights for mast-head and red and green side lamps, with more certainty and regularity than have yet been achieved in the gas supply for any house on *terra firma*.

I must apologise for trespassing so largely on your space. My apology is that the subject is exciting great interest among the public, and that even so slight an instalment of information and suggestions as I venture to offer in this letter may be acceptable to some of your readers.—I remain, your obedient servant,

William Thomson.

The University, Glasgow, June 6.

SIR HENRY COLE ON TONIC SOL-FA.

At the annual meeting of the Tonic Sol-fa College, held on Monday evening, May 30th, at Exeter-hall, the Chairman (Sir Henry Cole, K.C.B.), said he would begin his speech by prophesying that the Tonic Sol-fa method would become the 'universal method of teaching music in the public schools of the United Kingdom, and be the first step in the national cultivation of music,' and he continued, "Am I justified in making that statement? I will try to justify it, and, with your leave, account for my presence here. I crave your patience whilst I unravel the threads of my reasons, and give you the sequence of atoms of facts which have brought me before you as the advocate of the Tonic Sol-fa method, of which I knew very little three months go, but which I now am persuaded, upon the best authority and with such judgment as I can put upon it, is by far the best method of introducing music generally into this country. I am no musician, but at ten years old I did what many of you do—played the flute; an instrument then worked by the fingers, and not by keys, as it is at the present time. I also at one time took up the bassoon, and fifty years ago, at the instigation of the late John Stuart Mill, I attempted to play the pianoforte, but with very trifling success. Then I plunged into a superficial study of harmony, and particularly of Colonel Thomson's work. Of course with that great amount of knowledge I became a musical critic. I witnessed the great Lablache's first appearance at the Italian opera, when he was assisted by Malibran, who was then thought a divinity, and I may say by the way, that a week after I saw the first appearance of Taglioni, who, as the newspapers said, floated on the stage like eider-down. I then took some lessons in singing, and after having begotten children, I became an editor of traditional nursery songs. Fifty years ago there was no parliamentary grant for national education. There was no such singing in our churches as we have now. If any of you know the South Kensington Museum you will have seen a picture there by Thomas Webster, which is called 'The Village Choir,' and if you want to know what village choirs were fifty years ago look at that picture. Somebody said it was a Protestant version of the Gregorian chant, but it will give you an idea of how music was cultivated in our churches at that time. There was no Sacred Harmonic Society, which came to this hall, and has gone. Exeter-hall was not even built then. There was no such great organisations for public singing as now exists. The Tonic Sol-fa system, although invented, was not heard of publicly. In 1871, however, vocal music in elementary schools was introduced into the Code—you know what the Code is, some of you; at least, I hope you do—it was introduced into the Code by Mr. Forster, to whom the nation mainly owes the introduction of national education. He introduced those words, 'vocal music,' into the Education Code of 1871; but before him, more than twenty years before, Dr. Kay (afterwards Sir J. Kay-Shuttleworth) had taken up the matter as far as the teachers' certificates were concerned, and Dr. Hullah even then looked after the music, and the teachers were credited with musical honours if they deserved them. Now—you will hardly believe it, those who do not know the mystery of the thing—the teachers get no credit for music at all in their certificates. You, the taxpayers, vote through your representatives £136,000 a year for bad singing—I will not call it music—and yet the teacher who has to impart this knowledge is not recognised as knowing anything about it. After these words 'vocal music' were brought into the Code, Lord Sandon—Heaven knows why—took them out and put in 'singing by ear.' In a fit of desire for popularity he reduced 'vocal music' to 'singing by ear.' Lord George Hamilton succeeded him, and he restored the words 'vocal music' and kept 'singing' also. It was ruled—'If you can pass in the Tonic Sol-fa method you can have the 1s. for vocal music, but if you only sing by ear you shall only have half the grant you get for vocal music.' Now, there is a mystery about the next change which 'no fellow can understand.' Mr. Mundella, whose zeal for education no one can doubt, immediately on coming to power, expunged 'vocal music' again. The teachers are still examined in music, and very well examined by Dr. Hullah, but they get no credit for it, and the managers of schools are told nothing about it in the certificates—the knowledge of music is not recorded in the certificate at all. Dr. Kay, who was the organiser of our national education, was the man who put it in; but who persuaded my Lords to put it out, is a mystery which nobody can fathom. Now let me speak briefly about our various academies for musical education. First we have the Royal Academy of Music, which at first led a struggling life, but by putting its shoulder to the wheel it has got out of difficulty, and is now a very flourishing institution, with its £13,000 a year. Since the Royal Academy was established, there has been a National Training School of Music established by the Society of Arts, which is doing its work fairly well, but both these institutions are bound to begin with the Tonic Sol-fa method, and to use the College for their purpose. Whilst the Tonic Sol-fa system was marching on in triumphant progress, every other system seemed on the whole to be going back. They had 29,000 schools that might be taught the Tonic Sol-fa method. They had only 1,300 taught by the Hullah, or the old notation, or the movable Doh, or anything else, but the Tonic Sol-fa, as they heard from the report, had more than 4,000 teachers, and before it had done its work in England it must get up to that 30,000, and it would do so. It is the easiest and most scientific system to begin with; it leads easily to the old notation. It is supported by such authorities as Professor Macfarren, Dr. Sullivan, Dr. Stainer, and, in fact, by every musician who will trouble himself to understand it. It will greatly aid the work of the Society of Arts in the national cultivation of music. May it prosper!"

CORRESPONDENCE.

MANUFACTURES, TRADE, AND PROGRESS OF ENGLAND.

When the founders of the Society of Arts established our Society, above a hundred years ago, for the encouragement of Arts, Manufactures, and Commerce, they did so to provide for the growing wants of our internal development, and also of our rising colonial empire. That design was so well laid, and has been so successfully carried on, that we are still actively engaged in its prosecution.

In that period, and particularly of later time, our external trade, on which the maintenance of our population chiefly depends, has acquired enormous proportions, but it is subjected to a most keen competition. Indeed the world is under new conditions. The provinces of America, which at our foundation may have had a million of people, showed at the census of last year above sixty millions of our English speaking men in the United States. They are consumers, it is true, of our manufactures, but still more active competitors after our own ways. Then, too, Europe is ever ready to compete with us.

Concurrently with the existence of our own Society, there have been established, partly by ourselves, many valuable institutions for the advancement of industry, not only Chambers of Commerce, but others, such as the Iron and Steel Institute, for technical improvement. Our own means and strength do not allow us to do the whole of this work, but only to co-operate in it, and they do not enable us to take charge of the general relations of our industry abroad.

At this time, as we deeply feel, we are being driven out of many a country by our American and foreign rivals, and, in some cases, the capital for these operations is obtained in our own market. Thus an American, a Belgian, or a Frenchman obtains the concession of some railway or public works, he places the securities in this country, and with the proceeds he obtains the iron, machinery, and plant from abroad, displacing us.

This is only one class of numerous operations illustrative of what is now going on, chiefly because there is no organisation of our industry, and not even a Ministry to look after our commerce abroad. Free trade does not mean free neglect of trade. To enter into the subject to any extent would take up great space, and only enforce facts, which come home to the bosom of every manufacturer.

Surely the time has come when some action, perhaps by the instrumentality of our Society, should take place, and when the Chambers of Commerce, the trade associations, and the individual manufacturers, miners, or merchants and shipowners should bestir themselves in convention and in concert to provide for their own and the national interests at home, in the colonies, in India, in America, and abroad, where, in many cases, some small care and assistance would preserve what is being wrested from us, or would open new markets for our products. Hyde Clarke.

GENERAL NOTES.

The International Medical and Sanitary Exhibition.—It is announced that the whole of the floor space for this Exhibition will be allotted this week, with the exception of a portion which the committee have decided to set apart for exhibiting the work of journeymen plumbers. Under special regulations this work will be exhibited free of charge, and it will include the specimens of workmanship produced by the competition for the prizes in connection with the lectures on plumbing now being delivered in the room of the Society of Arts. Plumbers wishing to exhibit should make early application for particulars to Mr. Mark Judge, at the Parkes Museum of Hygiene, University College, Gower-street. Certificates of merit will be awarded. H.R.H. the Duke of Edinburgh has consented to become the patron of the Exhibition.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 13th...Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Mr. E. Colborne Baber, "A Journey of Exploration in Western Szechuen."

Tuesday, June 14th...National Health Society (at the House of the Society of Arts), 7.30 p.m. Mr. S. Stevens Hellyer, "The Science and Art of Sanitary Plumbing." (Lecture III.)

Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.

Photographic, 5a, Pall-mall East, S.W., 8 p.m.

Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. J. Park Harrison, "Exhibition of Danish and French Photographs." 2. Major-General A. Pitt-Rivers, "The Discovery of Flint Implements in the Gravel of the Nile Valley, near Thebes." 3. Mr. Alfred Tylor, "The Human Fossil at Nice." 4. Mr. Gerrard A. Kinahan, "Sepulchral Remains at Rathdown, Co. Wicklow." 5. Mr. J. H. Madge, "Notes on some Excavations made in Tumuli, near Copiapo, Chili, in June, 1880." 6. Mr. F. E. im Thurn, "Some Stone Implements from British Guiana." 7. Mr. G. Bertin, "The Origin of the Semites."

Royal Colonial, Grosvenor Gallery Library, 136, New Bond-street, W., 8 p.m. Mr. F. P. Labilliere, "The Political Organisation of the Empire."

Royal Horticultural, South Kensington, S.W., 1 p.m.

Wednesday, June 15th...National Health Society (at the House of the Society of Arts), 7.30 p.m. Mr. S. Stevens Hellyer, "The Science and Art of Sanitary Plumbing." (Repetition of Lecture II.)

Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Charles Harding, "The use of Synchronous Meteorological Charts for determining Mean Values over the Ocean." 2. Mr. Robert Langley Holmes, "The Climate of Fiji." 3. Mr. J. A. B. Oliver, "Note on the Formation of Hail." 4. Mr. John G. Gamble, "Note on a comparison of Maximum and Minimum Temperature and Rainfall observed on Table Mountain, and at the Royal Observatory, Cape Town, during January and February, 1881."

Thursday, June 16th...Domestic Economy Congress, Royal Albert Hall, Kensington, S.W., 11.30 a.m. Lecture by Mrs. Buckton on her "Method of Teaching Domestic Economy."

Royal, Burlington-house, W., 4½ p.m. 1. Dr. Wall, "The Differences in the Physiological Effects produced by the Poisons of certain Species of Indian Venomous Snakes." 2. Dr. Brunton and Dr. Cash, "The Effect of Electrical Stimulation of the Frog's Heart, and its modification by Cold, Heat, and the Action of Drugs." 3. Mr. Charles Wesendonck, "Note on the Spectrum of Carbonic Acid." 4. Dr. Brunton and Dr. Cash, "Action of Ammonia and its Salts, and of Hydrocyanic Acid upon Muscle and Nerve." 5. Messrs. W. Spottiswoode and J. F. Moulton, "Stratified Discharges —VI. Shadows of Striæ." 6. Mr. W. Galloway, "The Influence of Coal Dust in Colliery Explosions." (No. 3.) 7. Prof. J. A. Ewing, "Effects of Stress on the Thermo-electric Quality of Metals." (Part I.) And other Papers.

Antiquaries, Burlington-house, W., 8½ p.m.

Linnean, Burlington-house, W., 8 p.m. 1. Surgeon-Major Aitchison, "Flora of the Kuram Valley (Afghanistan)." Part II. 2. Mr. Robert McLachlan, "The Neuroptera of Madeira and Azores." 3. Prof. Count Ficalho and W. P. Hiern, "Central African Plants collected by Major Serpa Pinto."

Chemical, Burlington-house, W., 8 p.m. 1. Ballot for Election of Fellows. 2. Mr. W. H. Perkin, "The Isomeric Acids obtained from the Ethers of Salicylic Aldehyde and from Coumarin." 3. Dr. H. E. Armstrong, "Notes on Napthalene Derivative." 4. Mr. G. S. Johnson, "The Synthetical Production of Ammonia." 5. Mr. S. Pickering, "The Sulphates of Aluminium."

Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. W. Cave Thomas, "Light."

Royal Historical, 11, Chandos-street, W., 8 p.m.

Numismatic, 4, St. Martin's-place, W., 7 p.m. Annual Meeting.

Philosophical Club, Willis's-rooms, St. James's, S.W., 6½ p.m.

Friday, June 17th...Royal United Service Institution, Whitehall-yard, 3 p.m. Captain H. Watken, "Range and Position Finders, Past and Present."

Philological, University College, W.C., 8 p.m. Mr. Herbert M. Baynes, "The Psychological Method in its Application to Language."

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, JUNE 17, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One-Hundred and Twenty-seventh Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurer's statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new Members, will be held, in accordance with the Bye-laws, on Wednesday, the 29th of June, at 4 o'clock p.m.

The Council think it well to call the special attention of Members to the above notice, and to express their hope that Members may find it convenient to attend, and receive the report of the Council on the work of the Session.

(By Order of the Council)
H. TRUEMAN WOOD,
Secretary.

ALBERT MEDAL.

The Council of the Society of Arts have awarded the Albert Medal of the Society of the present year to August Wilhelm Hofmann, M.D., LL.D., F.R.S., Professor of Chemistry in the University of Berlin, for "eminent services rendered to the industrial arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England."

MEDALS.

The Council have awarded the Society's Silver Medals to the following readers of papers during the Session 1880-81:—

To Professor ALEXANDER GRAHAM BELL, for his paper on "The Photophone."

To E. PRICE EDWARDS, for his paper on "Signalling by Means of Sound."

To ALEXANDER SIEMENS, for his paper on "The Electrical Railway, and the Transmission of Power by Electricity."

To the Right Hon. Sir HENRY BARTLE EDWARD FRERE, Bart., G.C.B., G.C.S.I., D.C.L., LL.D., for his paper on "The Industrial Products of South Africa."

To J. Y. BUCHANAN, F.R.S.E., F.C.S., for his paper on "Deep Sea Investigation, and the Apparatus used in it."

To Professor JOHN PERRY, for his paper on "The Future Development of Electrical Appliances."

To Sir RICHARD TEMPLE, Bart., G.C.S.I., C.I.E., D.C.L., for his paper on "Forest Conservancy in India."

To J. M. MACLEAN, for his paper on "The Results of British Rule in India."

A vote of thanks was given to W. H. Preece (Member of Council), for his paper on "Recent Advances in Electric Lighting."

DOMESTIC ECONOMY CONGRESS.

The Domestic Economy Congress in connection with the Society of Arts will be held during the week from Monday, 20th June, to Saturday, 25th June. On Monday evening there will be a *Conversazione* and Musical Promenade in the Royal Albert-hall and Conservatory of the Royal Horticultural Society at 8 p.m. The meetings for the readings of papers and discussion will commence on Tuesday, and will be held in the Great Room of the Society on Tuesday, Friday, and Saturday, at 11 a.m., and on Wednesday and Friday evening, at 7 p.m. The meetings Wednesday morning and on Thursday will be held at the Royal Albert Hall.

Mrs. Buckton's lecture at the Royal Albert Hall will be repeated, by special desire of H.R.H. the Princess Christian of Schleswig-Holstein, on Thursday, June 23, at 4 p.m.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, is now open daily. A non-transferable season ticket will be sent to any member of the Society on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

EFFORTS TO IMPROVE NATIVE HUSBANDRY IN SOUTH INDIA.

By Wm. Robertson.

(*Continued from p.* 620.)

In Madras, the Educational Department is now beginning to give attention to agricultural instruction, the subject being now taught in several of the rural schools; but nothing of a comprehensive nature can be done in this way, until qualified agricultural teachers are available. And men can become so qualified only by undergoing training in the Madras Agricultural College, which, at present, is the only institution of the kind in the whole of India, and which, I venture to believe, is as fully deserving of State support as any other technical institution in the country.

I never could understand the nervous fear that appears to exist in some quarters, lest students of the college should look to State employment as affording a career in after life. The State employs, in the administration of its vast landed estate, thousands of officials of all grades, who are totally without any agricultural education. Many of these officials are employed solely in valuing the land for rent, in collecting agricultural statistics, and in many other ways connected with agriculture. Surely there can be nothing wrong in any agricultural student looking forward to employment in any of these capacities, provided he possesses, in addition to his agricultural knowledge, the qualifications all must possess who seek for such employment. I should have thought that, for the performance of agricultural duties, preference would be given to men who possess a knowledge of agriculture; but so far, graduates of the Agricultural College have encountered nothing but difficulties in seeking for State employment where a knowledge of agriculture seems essential. From what I can gather, it appears that the obstacles are put in their way chiefly by the officials of the inferior classes, who do not like the idea of better educated men than themselves getting admission into their ranks.

The Agricultural College has been organised as the central institution for agricultural training in the Presidency of Madras, and it was intended only to afford higher agricultural education. It was proposed that elementary instruction in agriculture should be afforded in the high school of each district with which the branch experimental stations were to be connected, but, as yet, none of these agricultural classes or stations have been established. The college suffers from the absence of these classes, which were intended to be its main feeders; while the course of training in it has been prolonged, from the necessity of the institution undertaking elementary as well as more advanced instruction.

Youths of the ordinary ryot class, the sons of small occupiers, will, in the agricultural classes, at the high schools and middle-class schools in the districts, meet with such facilities for gaining a knowledge of the principles of agriculture as appear suited to their requiremets. The sons of ryots of the better class, and of small zemindars, with others who desire a more complete agricultural education, will, it is proposed, pass from the local agricultural instruction classes to the college at Saidapet.

I have dwelt at considerable length, and in much detail, on the subject of establishing the Agricultural College at Madras, because I am anxious that the facts should be thoroughly known and appreciated. The experiment is one of the utmost importance in India, and it should receive fair treatment. Should any erroneous conclusions be formed regarding it, agricultural education, so much needed in that country, may be retarded for years. There are always a number of persons ready to cry out failure when anything new is being tried, and already there are persons glorying in the fact, as they assume it to be, that the college has not been a success, as if it was yet possible to form any definite conclusions on an experiment of such a nature, and conducted under so many difficulties. These persons assert that the bursaries drew the students, and that, when the bursaries were done away with, the attraction ceased. Such persons, however, altogether (willingly or unknowingly) misstate the facts. The bursaries were, undoubtedly, of much benefit to the students in enabling them to meet the heavy cost of not unfrequently long journeys to and fro between the college and their homes at the beginning and end of each session, and, indeed, also in meeting the personal expenses of the students at Saidapet. But many of the students must have spent a great deal more on travelling charges and text-books alone than the entire amount they received in bursaries, or scholarships. The aid thus originally given was only such as was barely necessary. It could in no sense be looked upon as an attraction sufficient to bring students hundreds of miles from their homes. The majority of them came from places more than 200 miles from the college, several from remote parts of the Bombay Presidency, to undergo hard training of a previously unknown kind for three years at the Agricultural College, more especially as there was no prospect held out as there is in the technical institutions of the Forest, Educational, Medical, and Engineering Departments of India, of State employment for successful students.

The Famine Commission have proposed a very extensive scheme of agricultural instruction for Indian civilians at the expense of the State. The cost that would be incurred, for affording each such civilian a knowledge of the principles of agriculture, would provide bursaries sufficient for the entire requirements of the Madras Agricultural College, and secure to it a regular attendance of at least 100 qualified students, while not adding to its working charges; for, I need hardly remark, that a course of lectures for a class of seven or eight students is quite as costly as for a class of thirty or upwards. The benefit that would result to India from the general diffusion of agricultural knowledge amongst the rural classes cannot be overvalued. If, as the Famine Commission report asserts, great benefit would result to India if the European Land Revenue officers possessed a knowledge of the principles of agriculture, it surely is equally true, and, to a far greater extent, that a similar knowledge amongst the thousands of native officials scattered over the country, in close daily intimacy with the agricultural classes, would be productive of far more good in the promotion of agricultural improvement.

Ordinary education, which is gradually spreading its beneficial influences over the country, will, in time, create inquiry, even in the mind of the ryot, and efforts to improve the present state of matters will, no doubt, be made; but the general reform so urgently needed in the husbandry of the country, would not, in this way, be secured in the next 100 years, and the demand for reform is of far too urgent a nature to wait for even a single year's delay. Seeing that the State in South India, though administered by Englishmen, grudgingly spends the one-ninth per cent. of its rent-roll, for promoting agricultural improvement throughout the Presidency, there is nothing surprising in the fact that native landowners should be so apathetic regarding the condition of their properties, and the well-being of their tenantry. Before any decided comprehensive improvement can be made in native husbandry, agricultural education

must be placed within the reach of every class of agriculturist. The fact that the land pays four-fifths of the gross revenue of the Presidency, and that two-thirds of the population are employed in the cultivation of the land, should never be lost sight of in considering questions relating to the improvement of Madras agriculture.

I have already referred to the establishment of the Central Experimental Farm at Saidapet. The following extract from a report submitted by me to Government, shows the nature of the work in which the farm is engaged:—

"The farm being the only one of the kind in South India, it has, necessarily, been obliged to undertake much work in experimental agriculture, of a kind not usually undertaken by experimental farms in other countries. From the almost entire absence of any writings on the agriculture of the country, the ignorance of the people generally who are engaged in agricultural pursuits, and the imperfect character of the records of the results of previous efforts in improving native agriculture, there was no choice but to institute on the farm experiments of a very elementary character. It will readily be understood that experience gained in this way accumulates but very slowly, as each result needs to be confirmed under different conditions and circumstances before any decided conclusions are possible. The institution has had to do the work of an acclimatisation and agricultural society. It has been engaged in introducing and modifying machines, implements, and tools of other countries adapted to the requirements of Madras agriculture. Attention has been given to subsoil drainage, improved methods of tillage, the restoration of exhausted soils, the utilisation of irrigation water, the fertilisation of arable soils by the use of lime, saltpetre, oil-cake, poudrette, and other manures available in South India, but hitherto unused by the ryot; the introduction of the new crops suited to the climate of India, and adapted for cultivation under an improving agricultural practice, such as maize, *Sorghum saccharatum*, Carolina paddy, Guinea grass, and other grasses; New Orleans and other improved varieties of cotton; tobacco of all kinds; the production of live fences in view to affording protection, shelter, and fuel; the introduction of water-lifts, barn-machines, ploughs, cultivators, reaping knives, &c., of improved construction, suited after undergoing modification for use in South India; the improvement of native live stock by careful breeding and feeding, and by importing and acclimatising animals of good breeds for interbreeding with native stock."

The following analyses, made shortly after the farm was established, will give some idea of the poverty of its soils at the time; the soils analysed were some of the best on the farm:—

Constituents.	No. 4 Field (east side). Surface soil.	No. 4 Field (east side). Sub-soil.	No. 1 Field. Surface soil.
	Per cent.	Per cent.	Per cent.
Alumina	4·420	2·060	3·240
Oxide of iron	1·800	2·900	1·350
Phosphate of lime	·240	·009	·120
Carbonate of lime	·700	·560	·310
,, magnesia	trace	trace	trace
Sulphate of lime	do.	do.	do.
Chlorides	1·080	·720	·900
Moisture	2·760	1·420	2·090
Organic matter	2·500	1·740	2·120
Sand	85·900	90·400	89·870
Total	99·400	99·809	100·000

The farm, being without natural pasturage of any value, it became necessary, soon after it was opened, to undertake experiments in producing fodder for the valuable stock it possessed. Attention was first given to the crops which, in Europe, furnish green fodder; but it was soon ascertained that, with the exception of Lucerne, they were ill-adapted for culture in the hot plains of South India. Most of the plants grew fairly well in the cold season, but died off immediately the hot weather set in. Amongst these crops were *Lolium perenne*, *Lolium Italicum*, *Trifolium incarnatum*, Lucerne, vetches, millet, and a great variety of pasture grasses. Seeds of grasses and fodder crops were also obtained from the United States, Mexico, New South Wales, Queensland, China, Egypt, Italy, &c. The prairie grass and buffalo grass of the United States, were quite unable to stand the great heat of Madras. Several varieties of native grasses from Queensland have thriven as well as could be desired, but they are far inferior to European grasses.

Guinea grass (*Panicum jumentorum*) has been thoroughly established, and now affords the chief pasturage at the farm. The cultivation of Guinea grass has been wisely extended. The grass is much coarser than any European pasture grass. All kinds of stock eat it freely, and thrive on it. When it was first introduced at the farm, it was grown as an irrigated crop. But it was thought, that if the habits of the plant could be altered, it might become adapted for cultivation on unirrigated land. Accordingly, several experiments were commenced with this view, the results of which have proved highly satisfactory. At the farm, at the present time, there are considerable areas of this crop, which, for at least three or four years, have depended entirely on the rainfall. This result has been obtained chiefly by inducing the plant to send its root deeper into the soil, and by gradually accustoming it to smaller and smaller applications of irrigation, water applied at gradually lengthening intervals, until finally discontinued. *Sorghum saccharatum* and *Sorghum Caffrorum*, imported from China, United States, and Australia have, through the farm, become thoroughly naturalised in Madras. When these valuable crops are more generally cultivated, there is every probability that the manufacture of Sorghum sugar will be largely engaged in. The experiments made at the farm show that both plants contain a large amount of sugar, that the saccharine juice is very easily extracted, and that the waste, after crushing, affords a very valuable cattle food. The Agricultural Department of Madras is using its best endeavours to extend the cultivation of these crops, chiefly in view to the provision of fodder for use in the hot dry season, when the natural pasturage is all burnt up. Crops of from 15,000 lbs. to 20,000 lbs. per acre of most excellent fodder have been raised on the poor soils of the farm, without the aid of irrigation, during growing periods, varying in length from eighty to one hundred and five days.

But by far the best results in growing fodder were obtained with the previously despised indigenous cereal crops of the country. Amongst these I may mention *Sorghum vulgare*, *Penicillaria spicata*, *Panicum Miliaceum*, *Panicum miliare*

Panicum Italicum, *Eleusine coracana*, and of the leguminous order, *Dolichos uniflorus*. Several of these crops, under very ordinary tillage, and without irrigation, have yielded crops of fodder of over 20,000 lbs. per acre, in periods of from seventy to one hundred days. With occasional irrigation *Sorghum vulgare* has, within twelve months, in several cuttings, yielded crops of fodder weighing upwards of 50,000 lbs. per acre, and in one experiment as much as 80,000 lbs. per acre was obtained, the plants standing generally over the ground about twelve feet high. The cost of producing fodder from these native plants is seldom higher than five shillings per ton, a price very considerably below its feeding value. The fodder is usually rich in saccharine matters, and very succulent and digestible.

Many experiments have been made with native grasses; the majority of them have been found to be very coarse, and almost worthless, excepting when very young. There is one grass, however, *Cynodon dactylon*, which gave very good results under high manuring and occasional irrigation. Further experiments are being made with native grasses, and with the grasses of other countries likely to thrive in South India. The discovery and extended cultivation of some really good grasses in South India would prove of immense advantage to the country.

Maize, introduced from America, Egypt, and North Australia, has thriven at the farm, and a large amount of seed has been distributed over South India.

Wheat of Northern India has been tried, but its cultivation has not yet proved a success, chiefly due to the great heat encountered at Madras. In some portions of the Presidency, at elevations of from 2,000 feet and upwards, wheat of fair quality may be produced, but, generally, the variety grown is inferior spelt variety.

Of fibre crops, many varieties have been introduced and cultivated at the farm. Of these, I may mention *Cannabis sativa*, *Corchorus capsularis*, *Crotalaria juncea*, *Linum usitatissimum*, *Bœhmeria nivea*, and cotton of various kinds.

When the farm was instituted, it was believed generally that cotton could not be grown successfully on such light soils as those constituting the farm. However, it has been shown most conclusively there, that abundant crops of very fair cotton can be produced at a profit; while, over the Presidency generally, on soils far superior to those of the farm, the yield of clean lint is only, on the average, about 60 lbs. per acre; the average outcome per acre on the farm is fully three times this weight, while the price obtained is as high as for any cotton produced in South India. The farm has grown extensively Egyptian, New Orleans, Upland, Lea island, Yea valley, and other varieties, the seed of which has been distributed to native cultivators, and others. Many other kinds of crops have been experimented with; crops obtained from tropical countries abroad; crops introduced from the other provinces of India; and crops of South India not generally cultivated, or badly cultivated, apparently deserving of attention. But I cannot occupy your time in referring more fully to these crops. Those who are interested in the matter, and who wish for further information, will find full details in the annual reports of the Madras Agricultural Department, and in the "Saidapet Farm Manual," the latter a compilation from these reports.

During the last ten years, many field experiments have been conducted at the farm with manures available in South India, but which, until recently, were almost unused in native husbandry. The results obtained with these manures have been widely published in the reports of the department, and by other means. The experiments have shown that there is a great amount of valuable manure now wasted which the ryot could, with great advantage, apply to his starved soil.

Seeing that South Indian agriculture is so dependent on irrigation water, the proper utilisation of this water has occupied a good deal of attention on the farm. It has been shown there that good crops of paddy can be produced, even on sandy soils, with an expenditure of water less than one-half the quantity generally used in native husbandry; results obtained chiefly by deeper tillage and the use of organic manures. Experiments extended to unirrigated land have shown that, with deep tillage and the moderate use of vegetable manures, these soils are enabled to take up large quantities of moisture from the air during night, and to retain and shore it; thus practically securing irrigation from the air. In this direction, a great deal could be done in developing the drought resisting powers of a large area of land in South India—a result the importance of which I need not occupy time in pointing out.

The heavy expense incurred by the ryot with his primitive arrangement for raising water from wells, early attracted the attention of the managing authorities of the farm, and many experiments were instituted with pumps and water-lifts of different kinds, driven by steam-power, wind-power, by cattle, and by manual labour. Several of the water-lifts, of the patterns most highly approved, have, for a long time, been regularly worked on the farm, thus affording native cultivators interested in the matter every opportunity of judging for themselves the working capabilities of these machines. One of these water-lifts, which can be made up by almost any village carpenter, raises the water at less than half the cost at which it is raised by the primitive arrangement generally used in South India. This improved water-lift has been constructed in many places from drawings, or models, supplied from the farm.

In my first paper (7th May, 1880) I referred very fully to the advantages the European pattern plough possessed over the ploughs employed by native cultivators. The Saidapet farm has now, for 12 years, been worked entirely by ploughs of the modern make. They are each drawn by a moderate sized pair of cattle, and driven by a single native ploughman. Ploughs have been imported from England, Sweden, and the United States. The light pony ploughs, made by Messrs. Howard and Co., of Bedford, and Messrs. Ransomes, Sims and Head, of Ipswich, have proved great successes. Some of the ploughs now working on the Saidapet farm, and that have been regularly worked there for the past 12 years, are still in a thorough working order; of course, they have been kept in thorough repair.

The results of the experiments made at Saidapet have shown conclusively that it is a great mistake to recommend ryots to buy low-priced ploughs simply because they are low-priced. It is a far greater economy to pay £2 or £3 for a really well-made iron plough, than to pay 10s. or 15s. for a rudely-constructed plough, made of wood with iron working-parts, which is constantly needing repairs—often when work is pressing—and seldom lasts longer than two or three years. There are certainly many ryots who do not possess the means wherewith to buy a plough of the kind I recommend, but there are tens of thousands who do. It would be as ridiculous to state that steam ploughs cannot be used in England, because each farmer has not the means to supply himself with such an apparatus, as to state that in India good ploughs of the modern shape cannot be introduced, because the ryots are too poor to buy these ploughs.

The improvement of live stock has occupied much attention. There are no facilities at Saidapet for maintaining a large breeding herd of cattle, but a number of bulls are kept there for improving the stock of the neighbourhood. A breed of cattle, imported from Aden, has been introduced with success. The breed is noted as a dairy breed. It is hoped that, by the use of bulls of this breed, the milk producing capabilities of the cows of the indigenous breeds may be considerably improved. When I mention that the average yield of milk of an ordinary native cow is less than two quarts per day, you will understand what room there is for improvement, an improvement which would be a benefit to the people generally, for nearly all would be consumers of milk, if they could obtain it at a moderate price. Experiments made on the farm show that an average cow of Aden breed will yield daily at least six quarts of good milk. Experiments have also been made in determining the milking capabilities, under good management, of different native breeds, and of crosses with European breeds. The housing and general management of horned stock have also received attention. How necessary this is, you will understand when I tell you that the cold rains which accompanied the cyclone that broke over the neighbourhood of Saidapet in 1877, destroyed, in the Revenue Division in which it is situated, 11,687 cattle, and 7,218 sheep, in a live stock numbering 30,000 head of cattle, and 16,000 sheep. On the farm, which was exposed to the full force of the cyclone, the loss was only three sheep. Shelter in India is almost as necessary for live stock as it is in England.

I should have liked to have described to you more fully the actual work of the Madras Agricultural Department, but I have already trespassed so far on your time and attention I must forbear. The reports before alluded to describe fully this work and such indications of progress in agricultural reform as have been ascertained. Looking back over a period of twelve years engaged in this uphill enterprise, though I cannot point out any great or bright examples of progress, I feel satisfied that much good has been done, chiefly in collecting facts and spreading information which, when the time comes for energetic work in agricultural reform, will bear fruit. Already, as I have pointed out, agricultural education, which would have been an impossible undertaking only a few years ago, is now beginning its beneficial influences in the country; influences which, I firmly believe, will do for Indian agriculture what could be attained by no other means.

MISCELLANEOUS.

FAURE'S SECONDARY BATTERY.

Since the publication of Sir William Thomson's letter to the Editor of the *Times*, on the electric storage of energy (printed in the *Journal* of June 10, p. 622), Professor Osborne Reynolds, F.R.S., of Owens College, Manchester, has written the following letter to the *Times*:—

"Although agreeing with every word of Sir William Thomson's letter in the *Times* of to-day, and entirely sympathising with his enthusiasm as regards the marvellous box of electricity, still I feel that it would have been desirable if, in pointing out the importance of this new discovery, Sir William Thomson had guarded against a very probable misconstruction of the purport of his letter.

"The means of storing and re-storing mechanical energy form the aspiration, not only of Sir William, but of every educated mechanic. It is, however, a question of degree—of the amount of energy stored as compared with the weight of the reservoir, the standard of comparison being coal and corn. Looked at in this way, one cannot but ask whether, if this form of storage is to be the realisation of our aspirations, it is not completely disappointing. Large numbers are apt to create a wrong impression, until we inquire what is the unit. Eleven million foot pounds of energy is what is stored in 1 lb. of ordinary coal. So that in this box, weighing 75 lb., there was just as much energy as in 1½ oz. of coal, which might have been brought from Paris or anywhere else in a waistcoat pocket, or have been sent by letter.

"When we come to the question of the actual conveyance of energy for mechanical purposes, this view is of fundamental importance. The weight of the same amount of energy in the new form is 800 times greater than the equivalent amount of coal; and as a matter of economy, supposing that energy in this form might be had at a certain spot, and no capital were required for its conversion or storage, and that the energy were directly applicable, it could not be carried ten miles—that is to say, such energy cannot be economically useful ten miles from its source, although coal had to be carried 100 miles to the spot. This limit, in truth, falls far short of what has been already obtained by other means. By wire ropes, and by compressed air or steam, energy may be economically transmitted from 10 to 20 miles. So that if this is the utmost of what is to be done by means of the storage of electricity, this discovery adds another door to those which are hopelessly closed against the possibility of finding in Niagara or other water power a substitute for our coal, even when the object is motive power, and much more for that purpose for which five-sixths of our coal is used—the production of heat.

"It is very important that the people of this country should not shut their eyes to the fact that, so far from there being a greater prospect of the solution of the problem than when, about 20 years ago, Professor Jevons raised the alarm, the prospect is now much smaller. In the meantime, the capabilities of steel ropes, fluids in pipes, and electricity along conductors have been not only investigated, but practically tested and

found altogether wanting. And now it would seem that the storage of electricity must be added to the list."

Another letter on the same subject, from Professor W. E. Ayrton, F.R.S., appeared in the *Times* on the next day, which is as follows :—

"Professor Osborne Reynolds's letter in your issue of Saturday, the 11th inst., shows that the first idea that has occurred to him on reading Sir William Thomson's letter on Faure's 'electric store' is, probably, what must have suggested itself to many engineers, viz., that so far from a million foot pounds being a surprisingly large amount of energy to be stored up in a mass of 75 lb., it is really extremely small; and, indeed, while crossing over from Paris at the commencement of last week, I could not help thinking that the passengers were bringing to England, literally in the smuts and blacks on their coats, far more energy than had ever been imported into this country stored up in Faure's secondary batteries. But although it is perfectly true, as Professor Reynolds says, that 1½ oz. of coal contains about one million foot pounds of work stored up in it, this is by no means all that has to be taken into account in considering this question; for where is the engine for extracting this million foot pounds of work out of the 1½ oz. of coal? Indeed, as Professor Reynolds would himself tell us, we cannot get much more than one-tenth of this amount of work out of the 1½ oz. of coal, even in our largest steam-engines, which burn many pounds of coal per minute, and in which much heat has been wasted in getting up steam. And if we come to the burning of one single 1½ oz. of coal, I know of no engine that can obtain from this even one thousand foot pounds of work, or one-thousandth of the energy contained in the coal, if no other coal be used in getting up steam or in previously heating the engine.

"But if a secondary battery be allowed to drive a magneto-electro-motor or a dynamo-electric machine with separate exciter, only even for the short time necessary to develop, say, 30 foot pounds of mechanical work, I anticipate this can be done without using up in the whole process more than about 35 foot pounds of the electric energy stored up in the reservoir, since the experiments of Professor Perry and myself have shown that, when the motor is running at high speeds with a light load, as much as 93 per cent. of the electric energy put into a magneto-electro-motor is given out again as mechanical work measured by an absorption dynamometer.

"It may be answered, however, that if a small bit of coal, although containing a vast store of energy, is not of much practical use in producing work, in consequence of the absence, up to the present time, of a proper converter of the coal's energy into mechanical work, at any rate a small galvanic battery (a little Daniell's cell, for example) is not only a vast storehouse of power, but contains a store which we have the means of converting, without appreciable loss, into electric light or mechanical work. How, then, is a Faure's box a better store of electric energy than a little Daniell's cell? This question has precisely the same answer as, "Why is a pinch of dry gunpowder better than a pinch of wet?" Not because the dry gunpowder has more energy in it than wet, but because the energy stored up in the dry gunpowder can be all, if we wish, used up quickly, and an explosion produced, whereas that in the wet can only be utilised bit by bit. So seven Faure's boxes will produce an illumination of 100 candles in Swan lamps for six hours, while seven Daniell's cells, or, indeed, twice that number, although possessing a store of power millions of times as great as that in the Faure's boxes, will not illuminate a single Swan light.

"But while fully recognising the great advance made in the subject by Planté, and the recent improvements introduced by Faure, I do not wish to give the impression that the problem is by any means completely solved, since, if the attempt that Mr. Perry and myself, no doubt like many other electricians, are making to convert at a low temperature the energy in coal into electric energy meets with even a fairly satisfactory solution, then a fragment of coal, or, it may be, a puff of gas rich in carbon or carbonic oxide, will be a practical store of energy of incomparably greater value than any secondary battery."

Sir William Thomson, writing on the 9th inst., points out that the credit of first alluding to Niagara as the natural and proper chief motor for the whole of the North American Continent, is due to Dr. C. W. Siemens, F.R.S., and adds, "that, under practically realisable conditions of intensity, a copper wire of half an inch diameter would suffice to take 26,250-horse power from water wheels driven by the Fall, and (losing only 20 per cent. on the way) to yield 21,000-horse power at a distance of 300 British statute miles; the prime cost of the copper amounting to £60,000, or less than £3 per horse power actually yielded at the distant station."

In a letter of the 11th inst., Sir William Thomson writes further :—

"It will be seen that I thoroughly sympathise with Professor Osborne Reynolds in his aspirations for the utilisation of Niagara as a motor, but that neither Mr. Siemens nor I agree with him in the conclusion which he asserts in his letter to you, published in the *Times* of to-day, that electricity has been tried and found wanting as a means for attaining such objects. The transmission of power, however, was not the subject of my letter to you published in the *Times* of the 9th inst., and Professor Reynolds's disappointment with M. Faure's practical realisation of electric storage, because it does not provide a method of porterage superior to conduction through a wire, is like being disappointed with an invention of improvements in water-cans and water reservoirs, because the best that can be done in the way of movable water-cans and fixed water reservoirs will never let the water-carrier supersede water-pipes, where-ever water-pipes can be laid.

"The 1½ oz. of coal cited by Professor Osborne Reynolds as containing a million of foot pounds stored in it, is no analogy to the Faure accumulator containing the same amount of energy. The accumulator can be re-charged with energy when it is exhausted, and the fresh store drawn upon when needed, without losing more than 10 or 15 per cent. with arrangements suited for practical purposes. If coal could be unburned—that is to say, if carbon could be extracted from carbonic acid by any economic process of chemical or electric action, as it is in nature by the growth of plants drawing on sunlight for the requisite energy—the result would be analogous to what is done in Faure's accumulator."

[In Sir William Thomson's letter, p. 622, col. 2, l. 29, "its own" should read "my own."]

THE CULTIVATION OF WHEAT-STRAW, AND THE MANUFACTURE OF STRAW GOODS IN TUSCANY.

For centuries the manufacture of straw hats has been a special art in Tuscany, and Signa, one of the most industrious of Tuscan towns, was for a long time the centre of the trade, which, however, was of little importance and limited until the seventeenth century, when it commenced to attract considerable attention, and large quantities were manufactured both for home use and for exportation. There are three varieties of wheat of the golden plant (pianta della fila d'oro), as straw is called in Tuscany, the first is called "Pontederas semone," which produces the best straw for hats; the second, "Marzuolo," which is of a rather common quality; and the "Santa Fioro," which is only used for pedals and braids. The Pontederas semone is sown in

arid soil, while the other two varieties require a more fertile soil. Seed is sown in November and December, according to the season, the object being to have the grain well up before the heavy frosts come, in the proportion of eleven hectolitres to each hectare, that is, about $12\frac{1}{2}$ bushels to the acre. It is sown as thickly as possible, in order that the growth of the plant may be so impoverished as to produce a thin stalk, at the same time having towards the end from the last knot the lightest and longest straw. Side hills, with a gravelly soil, and high meadow lands that have had a surface ploughing and rough harrowing, are specially adapted to the straw culture, low swampy gronnds being generally avoided, as dampness when the stalk is well grown renders the straw discoloured and coarse. The ground is ploughed and dug up in June, and left in this condition until November, when the soil is again turned up, and then it is ready for sowing. If the soil is very poor and thin, a very light surface of manuring is occasionally used, but this is not frequently resorted to, as it is apt to render the stalk thin and brittle. The wheat blooms at the end of May or beginning of June; it is generally pulled out by hand by the roots when the grain is half developed. For uprooting the straw, fine continued sunny weather is selected, as the rain has a very injurious effect upon it, often turning it black. When uprooted, the branches are tied together in sheaves, each sheaf, or "menata," is spread out in the shape of a fan to dry in the sun, from three to five days after which it is stowed away in barns, The harvest being over, and the fields being only in stubble, the straw is again spread out to catch the heavy summer dews, and to bleach in the sun for four or five days, but not the whole of the crop at the same time for fear of a sudden rain. During this process it is carefully turned until all sides are equally white. Formerly the yellow colour of the straw was preferred, but now the extra white is more sought after. Before being ready to be made up into braids, hats, and ornaments, the straw has to be again bleached, fastened in small bundles, and classified. It is then cut close above the first joint from the top, and again tied up in small bundles containing about sixty stalks in each. These small sheaves are then submerged in clear water for four or five minutes, and as soon as they become partially dried, are submitted to the action of burnt sulphur (in the proportions of one pound to one hundred bundles of straw) for three or four nights, in rooms adapted for the purpose; during the day the doors of these rooms are left open. The classification of the straw is made according to length and colour, the ear or end of the stalk having been previously cut off; all the straw below the first knot is used simply for forage or bedding, as it is worthless for the purpose of making braids or hats. There are no factories, says the United States Consul at Florence, for working up straw, but in almost every private dwelling of the lower classes will be found one or more of the female inmates attending to her domestic duties, and at the same time making braids and sewing on hats. A ready sale is found for their work at the nearest market, though, in many instances, special contracts are made by the "fattores" (straw brokers) with the workwomen directly, they supplying the straws into which the braids are made up. Many women make from 28 to 34 yards of braids a day, and some can finish even 60 yards of common braids, but fine braids require very great care and cleanliness. Owing to the great strain upon the eyes, the finer kinds of braids can only be worked upon from two or three hours each day; it takes, therefore, a woman from four to five days to make braid sufficient for the hats usually worn by men, while for the superior Leghorn hats for ladies it requires from five to nine months for each hat. It is a noticeable fact that, in several districts where the finer hats are made, the workwomen suffer greatly from affection of the eyes, caused by too close application to this kind of labour. Between 1822 and 1826, women employed in making braids realised from 6s. to 7s. a day, but at the present time the best braid-makers and hat-sewers only make about 1s. The most important centres of the straw industry are Brozzi, Signa, Prato, Fiesole, the Casentino, the Bolognese, and the Modenese. The province of Casentino is one of the most industrious in Tuscany, producing from 300,000 to 400,000 hats yearly, all for exportation. These hats, though hitherto comparatively unknown, are now very much sought after, on account of their strength and cheapness, prices varying from 4d. to 1s. each. In the Bolognese, the straw manufacture is confined chiefly to the mountain districts along the base of the Apennines, where the inhabitants of seventeen parishes are engaged in making the cheaper and coarser kinds. Laino and Searicalasino are the centre of this trade. Bolognese hats are brought to Florence to be fashioned, and the price paid is from 1s. 6d. to 2s. 6d. per dozen, and the quantity brought amounts to about 120,000 dozen yearly. For the last thirty years the annual exportation of straw goods from Tuscany averaged 12,000,000 lire, 5,000,000 lire alone being exported to the United States in 1878. By a comparison of the three principal products annually exported from Tuscany, straw goods show a value of 12,000,000 lire; silk, 5,000,000 lire, and timber, 4,000,000 lire.

UNITED STATES POST-OFFICE.

The United States Post-office Department has issued a statement of the results of an inquiry as to the amount and distribution of the postal business of the country during the year ending Dec. 31, 1880.

The whole number of letters posted was	1,053,252,876
,, ,, ,, post-cards ,,	324,556,440
,, ,, ,, newspapers ,,	812,032,000
,, ,, ,, magazines and other periodicals	40,148,792
The whole number of packages of merchandise	21,515,832
Various	468,728,312
Total	2,720,234,252

The number of letters posted average twenty-one for each man, woman, and child in the United States. This total is then analysed, and the relative numbers of each State given in a table. The two extremes are, Alaska, with its unlettered population, and the district of Columbia, the centre of the postal system, and the seat of National Government. In Alaska, only one inhabitant in five is credited with one letter a year, while in the district of Columbia there are 85 letters posted for each inhabitant. The most letters are written where there is proportionally the largest intelligent adult population who are away from home, namely, the newer States and Territories. Colorado heads the list of letter-writing communities, with fifty-five and a fraction to each inhabitant. The settlers in Arizona write 32 letters each a year, Dakota 30, Montana 40, Nevada 32, California 26, Idaho 25, and Wyoming 42. The States, which supply most of the letter-writers of the Territories, in addition to being the great seats of manufactures and commerce, come next, New York, with 42 letters to each inhabitant, Massachusetts with 39, Connecticut with 38. The people of the South are not letter-writers generally, nor are they as much given to migration as the people of the north. The result is that the contributions of the Southern States to the mail bags are extremely small. The annual average for each inhabitant of Alabama is 7, Arkansas 8, Georgia 9, Kentucky 9, Mississippi 6, North Carolina 6, South Carolina 7, Tennessee 7, West Virginia 8. The figures for other Southern states are, it will be seen, somewhat

higher:—Florida 11, Virginia 11, Texas 12, Louisiana 15, New Mexico 13. The more Northern States which write the fewest letters are Delaware 16, Indiana 13, Wisconsin 17, Washington Territory 15.

CINCHONA IN THE UNITED STATES.

Consul General Adams, of La Paz, Bolivia, states that he has no doubt but that the cinchona may be cultivated in some parts of the United States, where the soil and climate are favourable to its culture. After a full investigation into the cultivation of the *Cinchona calisaya* in Bolivia, he gives the following information to those wishing to make the experiment of growing the tree in the United States, which is taken from the *Oil and Drug News*:—"The seed is sown broadcast upon a hot-bed, such as gardeners prepare in the spring for their early vegetables. The manure of the llama, for which, in the United States, sheep manure might be substituted, is freely mixed with the surface soil of the hot-bed, and, as the seed is very high, it should be slightly raked under, and the surface kept moist. As soon as the sprouts appear a shade should be constructed over the bed covered simply with leaves, straw or branches of trees, which, while it protects the tender plants from the hot sun, may allow the rain to penetrate and fall gently upon them, and it is advisable to locate such hot-beds on a hill-side, so that the water may quickly run off, continuous and limited moisture being required, rather than quantities of water and heavy falls of rain. As soon as the plant has grown to a height of from six to eight inches, it is ready for transplanting. The ground chosen for a quina plantation should also be sloping, if possible on the south side of hill or mountain, as experience has shown here that those located on level land do not prosper, and steep mountain sides are here preferred. The plants are set at regular intervals eight feet apart, and it is only necessary, if not better, to prepare the soil within a foot of where each plant is placed, as I am assured that by ploughing the whole field too much moisture would be retained in the soil. The plants are then slightly covered with fallen leaves or other rubbish to protect them from the hot sun a while longer, until they show a strong and healthy growth, after which all further care seems to be unnecessary, in Bolivia at least, where even the weeds are but superficially removed. A damp, warm climate, with heavy dews at night, and cloudy sky during the days, rather than a hot, burning sun—such as may be found in the mountainous regions of some of the Southern States, like Alabama and Georgia, where mists and threatening clouds hang over the mountains in summer and still no severe frosts occur in winter—this seems to be what is required for the cultivation of this plant: and I should not be surprised if the experiment should, under such conditions, prove successful, a result which would, undoubtedly, add greatly to the wealth and prosperity of the South. Bolivia being in the southern hemisphere, the seasons for sowing and transplanting in the United States will have to be changed; the former, instead of October here, should be done in April, and the latter in July, instead of January here. From these intervals it will be seen that the seeds require a long period to germinate and attain their first growth, but from all accounts, if the above directions are followed, and a little patience shown in the beginning, very little, if any, cultivation and trouble is necessary after the plant is transplanted and becomes firmly rooted and shows a healthy growth. In from five to six years the tree grows to a height of about 10 feet, and 5 to 6 inches in diameter, and at that age the bark contains the greatest per-centage of quinine, and is worth in Bolivia from 180 dollars to 200 dollars per quintal of 100 pounds. When the tree has attained this size and age, it is cut down close to the roots, the bark stripped entirely from the trunk and branches, and one of the new shoots from the root is allowed to grow into a new tree. In India, I am told, the custom prevails to strip only half of the tree, and allow this to grow again before the other half is taken off; but by this process, I am assured, the per-centage of the sulphate contained in the second growth is much smaller than that gained by the method practised here. The seed which I have transmitted I have procured from one of the best plantations, and is warranted to be of the calisaya species—the best of the cinchonas. Lately, since the cultivation of this tree has assumed such large proportions in Bolivia, this seed has become an article of local commerce; so that, should the experiments in the United States prove successful, there would seem to be no difficulty in obtaining the necessary seed in larger quantities."

NOTES ON AMERICAN SCIENCE AND MECHANISM.

Increase of Immigration.

At no time in the history of New York have the statistics of immigration furnished such remarkable figures as at present. During the week ending May 28, the arrivals of immigrants were 20,178. On the Saturday of that week alone, the arrivals were 4,524, those of the day following being 4,197. Since the beginning of the present year, there have arrived, up to May 29, inclusive, no fewer than 183,558, which, when the returns of the 30th and 31st are added, and which will presumably be 8,000, will afford an accurate idea of the influx of immigrants into America through one port alone. The record for the month of May alone exceeds the total number for the year 1878. The emigrants are despatched to the Western States after a very brief stay in New York.

An Emigration Inspection Bill.

The Assembly has passed the Emigration Bill. It imposes a tax of a dollar a head on all emigrants entering the country by the port of New York, to be collected from the steam-ship companies bringing them, and devoted to defraying the expenditures under the Commissioners of Emigration. Emigrants are also to be inspected, so as to prevent foreign countries from exporting cripples, idiots, or other unsuitable people.

American Claims for the Invention of the Locomotive.

In connection with the centennial of the birth of George Stephenson, certain Americans are protesting against his being designated the "inventor" of the locomotive. This honour they claim for Oliver Evans, of Philadelphia, who, it is alleged, was the first to conceive the idea of a high-pressure engine, for which he obtained a patent in 1786-7. Five years before, Fulton went to Albany in the "Clermont," and twenty-five years before Stephenson built the "Rocket," Evans had in use a high-pressure engine, which was locomotive and steam-boat in itself, as it was driven by steam over the highway about a mile and a half, to the Schuylkill river, thence paddling its way by a stern wheel to Philadelphia. The construction of this engine, which was named "Eructor Amphibolis," is by the Americans conceived to warrant the title "inventor" of the locomotive being associated with the name of Evans rather than that of Stephenson, whose great genius they quite admit, although only as an improver rather than a first inventor.

[Evans's carriage, like all the early locomotives, was a common road carriage. He is stated to have worked it in 1772. He was before Symington (1786) and Murdock (1786), but later than Cugnot, who made a steam-carriage in France in 1769. None of these early inventors can really claim to be the inventor of the locomotive. Trevithick made a true locomotive in 1804

which ran on rails, as well as a steam-carriage; the former worked for some time on a circular tram near the present site of Euston-square in 1808. It was Stephenson's merit to have rendered the locomotive a practical reality. This is the credit which his true friends claim for him, and this will not be lessened by any of the more or less successful efforts of earlier inventors. No one with any knowledge of the early history of the steam-engine would assign the merit of inventing the locomotive to George Stephenson.—Ed. *S. of A. Jl.*]

INCREASING THE RAPIDITY OF LOCOMOTIVES.

An American mechanic, Mr. Fontaine, is seeking to improve the rapidity of the locomotive by the application of the principle that a small wheel, when driven by a large one, makes more revolutions than the motor wheel. With him it has not remained a mere conception, for it has passed into the experimental stage—an engine having been constructed on this principle. This engine drew a train full of high officials over the Canada Southern Railway, from Amherstbury to St. Thomas, a distance of 111 miles, in 98 minutes. That this trial trip was considered satisfactory, is evident from the fact that the officials have given orders for several engines to be constructed on the same model.

THE "HOLLAND HYDROGEN PROCESS" APPLIED TO THE STEAM-ENGINE.

Still another improvement upon the steam-engine, this one having reference to the method of heating the water. This is not effected by coke or coals as heretofore, but by hydrogen gas, which is generated as it is being used. The principle of forming gas by the union of super-heated steam with an hydro-carbon has long been known, but by the method adopted by Dr. Charles Holland, of Chicago, and hence named the Holland hydrogen process, it is stated that a greater degree of success has resulted than by any other. This system of heating was applied to locomotives more than a year ago, but it is only now that it has been improved in such a degree as to challenge public attention. By giving a brief account of an engine on the Flatbush and Coney Island Railroad, some idea will be had of the nature of the heating apparatus. The fire-chamber or furnace (eight feet by three) is floored with iron plates, in which are screwed 352 burners, which project upwards about two inches, each being enclosed by an open thimble which acts like a lamp chimney to its flame. In this chamber are also four strong iron retorts, which are connected by iron pipes with the water tank of the tender, an oil tank on the tender, and the steam space in the boiler. When sufficiently heated, the retorts pass super-heated steam and petroleum vapour together to the 352 burners, a certain number of which are under the retorts, and sustain their heat. From a carefully noted trial, the statistics of which have been furnished, it appears that it took seventy minutes to raise the steam up to ten pounds pressure, five and a-half gallons of oil having been used in doing so. In fifteen minutes more this pressure was doubled, at an expenditure of three and three-quarter gallons. After this the pressure increased with great rapidity and at a greatly decreased expenditure of the oil, which is a very cheap product in America. When the pressure reached about seventy pounds, it only required four minutes to raise it each ten pounds over this until it reached 120 pounds, the oil expended on each of these ten pounds being one gallon. The total time from lighting to the obtaining of the maximum pressure here mentioned (and after reaching which the engine was despatched on its journey) was two and a-half hours, twenty-six gallons of oil having been used. This oil, or naphtha, I have said, is very cheap, the whole cost of the twenty-six gallons being here only 78 cents., or 3s. 1½d. English money. When coal is employed to effect the same result, a ton and a-half is said to be required, costing 7½ dollars. It is considered that, at a cost of 36 cents. (1s. 6d.) per hour, a fast train may be run. The appearance of the flame is similar to that of pure hydrogen, that is, scarcely visible, although possessing great heating properties.

New York, June 1, 1881. J. T. T.

SWAN ELECTRIC LAMP AT PLEASLEY COLLIERY.

The Royal Commissioners upon Accidents in Mines, including Professor Abel, Mr. Warington Smyth, Professor Tyndall, and others, made an examination last week of the experiments on the application of electric lighting to coal mines, which are being carried out at the Pleasley Colliery, near Mansfield. The pits are about 1,600 ft. deep, and the workings are very extensive, but in the present instance the light was applied to three workings only, situated at a distance of about one-third of a mile from the bottom of the pits. The Swan system was adopted, and the arrangements were carried out by Messrs. R. E. Crompton and Co. The lamps themselves were enclosed in lanterns of a very ingenious construction, designed and made by Messrs. Crompton, which enabled the very fragile glass bulbs to be carried about without fear of accident, and at the same time rendered it impossible that the fracture of the lamp within could cause an explosion, inasmuch as the air inside the lantern would suffice for the instantaneous combustion of the carbon filaments before the flame could be communicated to the external air. In working the coal, the men undercut the face to the depth of some five or six feet, and the superincumbent mass is then brought down by wedges or blasting. It is said that the new lamp was found to be admirably suited for the requirements of the workers, since it not only gave a light many times as intense as the lights it replaced, but it was equally brilliant in whatever position it was placed, and it required absolutely no attention. In addition to the lamps which were used in the actual workings of the pit, the pit bottom was lighted up with similar lamps. The number of lights employed was 94 in all, which were worked by the current of an ordinary Gramme machine driven by a portable engine placed near the top of the upcast shaft.

CORRESPONDENCE.

MANUFACTURES, TRADE, AND PROGRESS OF ENGLAND.

The important and opportune contribution of Mr. Hyde Clarke, in our last *Journal*, is of such vital importance to the glory, wealth, and progress of this country, and the working classes in particular, that I venture to supplement his statement by some facts that are within my own knowledge, that confirm fully the truth and wisdom of his remarks, which I consider should be received by all leaders of opinion as a warning that the time has arrived when some action should be taken to demand of the Government the appointment of a Minister to look after our commerce, both home, colonial, and foreign, and to prevent in time the ruin that the one-sided free trade, regulated as it is against our countrymen in every trade and calling, is fast bringing about.

I will confine this letter to the following fact. Within the last few weeks it has come to my knowledge that one of our oldest established and well-known West India merchants' house in London has, with a view to counteract the impending ruin caused by foreign Government sugar bounties, opened a house of business in New York, that a few months has satisfied them and their British West Indian friends that it is much more profitable to send their sugars to that foreign country than to the old country. The experi-

ment is so successful, that they are about opening branch houses at Philadelphia, Boston, and Halifax.

The last West Indian mail brought me a letter from an old friend of forty years standing, in which he remarks:—"I consider West Indians are in a much better position than in my recollection, now that we have regular communication with, and sales in, America."

It was only recently that the *Times*, in supporting its well-known free trade views, admitted that our exports were falling off; that our imports paid for in money were enormously increasing; that our foreign trade in exports was diminishing, except in machinery (machinery to make goods to meet us in every market); and that we should do well to cultivate closer intimacy with our own colonies.

I have reason to believe that half the exports from the West Indies this year will be sent to the United States, and I am of opinion that in a very few years these once magnificent possessions of the English Crown will have peaceably passed away from us, to the serious loss of our working classes; for they may depend upon it that those who receive the sugar will manufacture the machinery to make more, construct the carts to carry it, supply all the numerous requisites required in this costly manufacture, clothe the ladies, educate and Americanise their children. And I am able to state that already the loss to us at home is very considerable, caused by our ships being disused, and those sailing under the stars and stripes being alone used in carrying in each direction the industry of the two countries, while old England allows her ships to rot in dock, and her once industrious population to be left out in the cold.

Depend upon it there is too much energy and good sense left in us yet, for this state of things to continue much longer, and the cry from the working classes will be, Protection to native industry.

HENRY LIGGINS.

3, Ladbroke-square, W.,
13th June, 1881.

NOTES ON BOOKS.

Legendary History of the Maoris. New Zealand, 1880. Folio.

This paper consists of a series of extracts from a compilation of the "Legendary History of the Maoris" which has lately been presented to both Houses of the General Assembly of New Zealand, and printed. From the memorandum, by Mr. John White, it appears that the different canoes that came to these islands were distinct migrations of the same people, all coming originally from one distant home; having parted in the Pacific Ocean, they had rested for a time, some in one group and some in another of the different clusters of islands. "These various migrations; or parts of a great migration, had evidently met and become partially amalgamated with other branches of a race previously located in those islands. By this contact the Maori had learned words of another language, and had modified and altered his mythology, thereby giving rise to the difference apparent at the reunion of the Maori people in New Zealand." Mr. White found names in a genealogy of the Kings of Hawaiki, or Sandwich Islands, printed in 1838, which are identical with those of chiefs given in the genealogy of the New Zealand, Takituma, and Arawa migration. In compiling this history of the Maoris, it is proposed "to give the oral traditions consecutively, placing those first which relate to actions most remote, giving, as far as practicable, in notes such of the parallel traditions which other Polynesians have preserved as may appear only relating to the same circumstances as those given in the Maori traditions, thus affording to those who may wish to continue the subject a starting-point for further research."

THE LIBRARY.

The following works have been presented to the Library:—

The Fields of Great Britain. A Text-book of Agriculture. By Hugh Clements. (London: Crosby, Lockwood, and Co., 1881.) Presented by the Author.

Horticultural Buildings. By F. A. Fawkes. (London: B. T. Batsford.) Presented by the Author.

Catalogue of the Library of the Institute of Actuaries. (London: Institute of Actuaries, Nov., 1880.) Presented by the Institute.

Aristology, or the Art of Dining. By Thomas Walker, M.A. With Preface and Notes by Felix Summerly. (London: George Bell and Sons, 1881.) Presented by Sir Henry Cole, K.C.B.

Chapters on the History of Old St. Paul's. By W. Sparrow Simpson, D.D., F.S.A. (London: Elliot Stock, 1881.) Presented by the Publisher.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 20TH...Domestic Economy Congress (at the Royal Albert Hall, S.W.), 8 p.m. *Conversazione* and Musical Promenade.
Asiatic, 22, Albemarle-street, W., 3 p.m.

TUESDAY, JUNE 21ST...Domestic Economy Congress (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m. Reading of Papers and Discussions.
Statistical, Somerset-house-terrace, Strand, W.C., 7¾ p.m. Mr. Hyde Clarke, "The English Stations in the Hill Regions of India; their Value and Importance, with some Statistics of their Products and Trade."
Zoological, 11, Hanover-square, W., 8½ p.m.

WEDNESDAY, JUNE 22ND...Domestic Economy Congress (at the Royal Albert Hall), 11 a.m. Evening Meeting (at the HOUSE OF THE SOCIETY OF ARTS), 7 p.m.
Geological, Burlington-house, W., 8 p.m. 1. Mr. R. F. Tomes, "Description of a New Species of Coral from the Middle Lias of Oxfordshire." 2. Prof. J. W. Judd, "Note on the Occurrence of the Remains of a Cetacean in the Lower Oligocene Strata of the Hampshire Basin." With a Note by Prof. H. G. Seeley. 3. Mr. G. H Hollingworth, "Description of a Peat-bed, Interstratified with the Boulder-drift at Oldham." 4. Mr. G. R. Vine, "Silurian Uniserial *Stomatoporæ* and *Ascodictyones*." 5. Mr. E. J. Dunn, "Notes on the Diamond Fields, South Africa." 6. Mr. P. H. Carpenter, "A New *Comatula* from the Kelloway Rock." 7. Mr. Sydney S. Buckman, "Descriptive Catalogue of Ammonites from the Sherborne District."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. C. F. Keary, "The Genuine and the Spurious in the Eddaic Mythology." Part II.
Sanitary Institute of Great Britain, 9, Conduit-street, W., 8 p.m. Prof. W. H. Corfield, "The Present State of the Sewage Question."
Royal Botanic, Inner-circle, Regent's-park, N.W., 8 p.m. Evening Fête and Floral Exhibition.

THURSDAY, JUNE 23RD...Domestic Economy Congress (at the Royal Albert Hall), 11 a.m. Reading of Papers and Discussions. 4 p.m., Lecture by Mrs. Buckton.
Antiquaries, Burlington-house, W., 8½ p.m.
Society for the Encouragement of Fine Arts, 9, Conduit-street, W., 8 p.m. Third *Conversazione.*
Royal Society Club, Willis's-rooms, St. James's, S.W., 6½ p.m. Annual Meeting.

FRIDAY, JUNE 24TH...Domestic Economy Congress (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m. and 7 p.m. (Teachers' Meeting.)
Royal United Service Institution, Whitehall-yard, 3 p.m. Captain J. R. Lumley, "The Promotion of Officers in the Prussian Service, their Training, and the Manner in which their Efficiency and Capability are Judged and Tested."
Philological, University College, W.C., 8 p.m. Mr. J. Marshall, jun., "Aryan Roots, and their changes in Semitic and Hamatic."
Quekett Microscopical Club, University College, W.C., 8 p.m. Mr. B. W. Priest, "A New Species of Sponge from Honduras."

SATURDAY, JUNE 25TH...Domestic Economy Congress (at the HOUSE OF THE SOCIETY OF ARTS), 11 a.m.
Physical, Science Schools, South Kensington, S.W., 3 p.m. 1. Mr. W. Grant, "Apparatus for Lecture Experiments on Current Induction." 2. Prof. Balfour Stewart and Mr. W. Strond, "Results of Experiments with a Modification of Bunsen's Calorimeter."
Royal Botanic, Inner-circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,492. VOL. XXIX.

FRIDAY, JUNE 24, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with sec. 40 of the Society's Bye-laws:—

TREASURERS' STATEMENT OF RECEIPTS, PAYMENTS, AND EXPENDITURE, FOR THE YEAR ENDING MAY 31ST, 1881.

Dr.

	£ s. d.	£ s. d.
To Cash at Messrs. Coutts and Co., 31st May, 1880	441 15 11	
Do. in hands of Secretary	4 15 7	
		446 11 6
,, Subscriptions received during the year from Members and Institutions in Union	6,005 10 0	
,, Life Compositions	609 0 0	
		6,614 10 0
,, Dividends and Interest		647 8 11
,, Examinations: — Prince Consort's Prize (H.M. the Queen)	26 5 0	
Fees, &c.	71 6 0	
		97 11 0
,, House & Office (receipts for gas, &c.)		31 0 0
,, Advertisements		1,457 13 4
,, Sales:—		
Barry's Etchings	13 10 0	
Cantor Lectures	26 19 6	
Domestic Economy Reports	1 13 9	
Journal	134 6 7	
Musical Education Reports	3 9	
Public Health Conference Reports	8 13 10	
Spoiled Post-cards	1 3 10	
Transactions	1 2 6	
		187 13 9
		£9,485 8 6

Cr.

	£ s. d.	£ s. d.
By House and Premises:—		
Rent, Rates, and Taxes	342 15 0	
Insurance, Gas, Coal, House charges, and charges incidental to ordinary meetings	272 9 3	
Repairs and Alterations (including new drains £247, and lavatory £91)	459 19 6	
		1,075 3 9
,, Office:—		
Salaries and Wages	1,838 1 11	
Stationery, Office Printing, and Lithography	288 3 8	
Advertising	100 15 1	
Postage Stamps, Messengers' Fares, and Parcels	209 6 5	
		2,436 7 1
,, Cleaning Barry's Paintings		37 0 0
,, Library, Bookbinding, &c.		108 13 2
,, Conversazione		234 4 9
,, *Journal*, including Printing, Stamps, and Distribution		2,016 12 2
,, Advertisements (Agents and Printing)		544 2 0
,, Union of Institutions, including Examinations, Prizes, Fees, Postage, Printing, &c.	433 12 6	
Prince Consort's Prize	26 5 0	
		459 17 6
,, Conference on Public Health, 1880		105 10 10
,, ,, Domestic Economy, 1881		73 8 10
,, Medals:—		
Albert (1879 & 1880)	42 4 6	
Society's (see also "Committees")	22 3 6	
		64 8 0
,, Prizes:—		
Owen Jones	10 5 0	
Sanitation of Houses	3 11 0	
		13 16 0
,, Cantor Lectures		208 8 6
,, Juvenile Lectures		21 9 0
,, Sections:—		
Applied Chemistry and Physics	74 11 0	
Foreign and Colonial	60 16 0	
Indian	51 0 0	
Sanitary	23 9 0	
		209 16 0
,, National Training School for Music		164 9 6
,, Committees:—		
Food	2 19 3	
Memorial Tablets	21 12 6	
Musical Education	14 9 8	
Patents	16 17 8	
Plant Labels	17 0	
Poisonous Colours	5 14 0	
Protection of Ships from Fire (including Medal)	21 16 6	
General charges	15 2 8	
		99 9 3
,, Art Workmanship Exhibition		5 7 3
,, Copyright (grant to Law Amendment Society)		10 10 0
,, Annuity to Mrs. Cantor	25 0 0	
,, ,, ,, Mrs. Le Neve Foster	100 0 0	
		125 0 0
,, Investment of Life Compositions (£609) and balance due to Endowment Fund (£93 9s. 9d.) in purchase of £709 12s. 10d. reduced 3 per cent. stock		702 9 9
		8,716 3 4
,, Cash at Messrs. Coutts and Co., 31st May, 1881	753 2 5	
,, Ditto in hands of Secretary	16 2 9	
		769 5 2
		£9,485 8 6

Liabilities.

	£ s. d.	£ s. d.
To Tradesmen's Bills	491 6 8	
,, Rates	43 15 0	
,, Examiners' Fees	54 12 0	
,, Examination Prizes	43 0 0	
,, Sir Walter Trevelyan's Prize	100 0 0	
,, Sections: — Colonial, Chemical, and Indian	170 0 0	
		902 13 8
Excess of Assets over Liabilities		8,617 6 10
		£9,520 0 6

Assets.

	£ s. d.	£ s. d.
By Society's Funds invested in—		
Reduced 3 per Cent. Stock, £4,754 7s. 7d., worth on 31st May, £4,778 8s. 10d., less £665 2s. 3d., reserved to meet Trusts stated below	4,113 6 7	
£217 Great Indian Peninsula Railway 4 per Cent. Debenture Stock, worth on 31st May	231 2 0	
		4,344 8 7
,, Subscriptions of the year uncollected	749 14 0	
,, Arrears, estimated as recoverable	300 0 0	
		1,049 14 0
,, Property of the Society, including Barry's Pictures and Lease		2,000 0 0
,, Advertisements on the Books due and in course of execution*		1,256 12 9
,, Cash at Messrs. Coutts and Co., 31st May	753 2 5	
,, Ditto on Deposit	100 0 0	
,, Ditto in hands of Secretary (Petty Cash)	16 2 9	
		869 5 2
		£9,520 0 6

* A portion of this sum is liable to charges for printing.

Stocks and Cash Standing in the Name of the Society.

	£ s. d.
Consols	£4,891 6 4
New 3 per Cents	388 1 4
Reduced 3 per Cents	4,754 7 7
United States 5 per Cent. Funded Bonds, 1871 (2,500 dollars)	509 1 3
Oude and Rohilcund Railway 5 per Cent. Guaranteed Stock	2,150 0 0
Bombay and Baroda do. do.	2,450 0 0
Canada 4 per Cents	423 0 0
India 4 per Cents	105 18 7
Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	2,170 0 0
Metropolitan 3½ per Cent. Stock	343 14 3
Cash on deposit at Messrs. Coutts and Co.	100 0 0

Trust Funds Included in the Above.

	£ s. d.	
1. Dr. Swiney's Bequest	£4,500 0 0	Consols, chargeable with a sum of £200 once in five years.
2. John Stock's Trust	100 0 0	,, ,, the Award of a Medal.
3. Benjamin Shaw's Trust for Industrial Hygiène Prize	133 6 8	,, ,, ,, Interest as a Money Prize.
4. North London Exhibition Trust	157 19 8	,, ,, ,, ,, ,, ,,
5. Fothergill's Trust	388 1 4	New 3 per Cents, chargeable with the Award of a Medal.
6. J. Murray, in aid of a Building Fund	50 0 0	Invested in Reduced 3 per Cent. Stock.
7. Subscriptions to an Endowment Fund	525 2 3	
8. Dr. Aldred's Bequest	90 0 0	
9. Thomas Howard's Bequest	500 0 0	,, ,, United States 5 per Cent. Funded Bonds, 1871.
10. Dr. Cantor's Bequest	5,052 19 8	,, ,, Bombay and Baroda and Oude and Rohilcund Guaranteed Railway Stock.
11. Owen Jones Memorial Trust	400 0 0	,, ,, Canada 4 per Cent. Stock, charged with the Award of Prizes to Art Students.
12. Mulready Trust	109 12 9	,, ,, India 4 per Cent. Stock, the Interest to be applied to keeping Monument in repair and occasional Prizes to Art Students.
13. Alfred Davis's Bequest	1,800 0 0	,, ,, Great Indian Peninsula 4 per Cent. Guaranteed Railway Debenture Stock.
14. Memorial Window Fund	345 0 0	,, ,, Metropolitan 3½ per Cent. Stock.
15. Sir Walter Trevelyan's Prize	100 0 0	On Deposit with Messrs. Coutts and Co.

The Receipts of the Society set forth above have been credited by Messrs. Coutts and Co.
The Payments set forth above have been made by authority of the Council.
The Assets, represented by Stock at the Bank of England, and securities, cash on deposit, and cash balance at Messrs. Coutts, as above set forth, have been duly verified.

B. Francis Cobb, } *Treasurers.*
Owen Roberts, }
J. Oldfield Chadwick, F.C.A., *Auditor.*
H. Trueman Wood, *Secretary.*

Society's House, Adelphi, 17th June, 1881.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One-Hundred and Twenty-seventh Annual General Meeting, for the purpose of receiving the Council's Report and the Treasurer's statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new Members, will be held, in accordance with the Bye-laws, on Wednesday, the 29th of June, at 4 o'clock p.m.

The Council think it well to call the special attention of Members to the above notice, and to express their hope that Members may find it convenient to attend, and receive the report of the Council on the work of the Session.

(By Order of the Council)
H. Trueman Wood, Secretary.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, is now open daily. A non-transferable season ticket will be sent to any member of the Society on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

DOMESTIC ECONOMY CONGRESS.

The Congress was opened on Monday evening, 20th inst., with a *conversazione* and musical promenade in the Royal Albert Hall and Conservatory of the Royal Horticultural Society. There was a display of flowers in the Conservatory of the Royal Horticultural Society, which, with the adjoining arcades, were illuminated by the following systems of electric lighting:—Siemens lamps, by Messrs. Siemens; the Maxim incandescent light, by the Electric Light and Power Generator Company; and the Crompton light, by Mr. R. E. Crompton. An instrumental concert was given by the band of the Royal Military Asylum, in the Royal Horticultural Society's Conservatory, and by the band of the Coldstream Guards, in the Royal Albert Hall. There was also a selection of vocal and instrumental music, by the scholars of the National Training School for Music, under the direction of Dr. Stainer; a selection of part-songs, by the students of St. Mark's Training College, conducted by Mr. Owen Breden, and by children taught on the Tonic Sol-Fa method, conducted by Mr. John Evans, Inspector of Singing to the Board School of London. The exhibition of school needlework by children in public elementary and other schools at home and abroad, was on view in the East Theatre of the Royal Albert Hall.

The meetings for the reading of papers and discussion commenced with the meeting of Section A., Methods of Teaching and Examining in Domestic Economy, in the Great Room of the Society on Tuesday, June 21st, 1881, the Countess of Airlie in the chair, with Sir Henry Cole, K.C.B., as assessor.

The first paper read was by **Lady Stuart Hogg**, on "The Teaching and Superintendence by Women in Elementary Schools."

Lady Stuart Hogg wished to add that, when abroad, she had often noticed how very helpless our countrywomen were. The husbands of the women, to whose ignorance of domestic matters reference was made in the paper, were certainly getting far better wages than many mechanics and railway clerks in England, and yet they were unable to save any money, from having to maintain so many servants. With regard to soldiers' wives, they were absolutely dependent on the ladies to cut out their things for them. She therefore thought that this movement would be of enormous value in making Englishwomen really as useful as the corresponding classes in both France and Germany.

The Rev. J. P. Faunthorpe, before reading the next paper, begged leave to state that he had recently heard that the inspectors of needlework in France were exclusively women.

Paper read was, "Suggested Outlines of a Plan for Establishing Women's Inspection of the Teaching of Domestic Economy by Counties," proposed by some members of the Executive Committee of the Congress (Sir Henry Cole, Rev. Newton Price, and Rev. J. P. Faunthorpe).

Mr. Mostyn Price (one of her Majesty's Inspectors of Schools for Monmouthshire) said all inspectors of schools would cordially agree with what had been said by Lady Stuart Hogg as to the desirability of inspection of needlework by ladies. He would, however, not wish to hamper them with so exhausting a work as a progress throughout the counties, and would suggest that some system should be organised rather for enabling the inspection to be carried out at headquarters. It might not be out of place altogether that, as a Government Inspector of Schools, he should offer a few remarks on the progress of teaching domestic economy in his district for the criticism of ladies present. Being a Government officer, acting under the direction of the Education Department, he must not be supposed for a moment to be officially criticising any part of the syllabus of the Code sanctioned by his superiors. And any remarks he might make, therefore, must be taken simply as offered in his private character of listener at this Congress. Mr. Price then gave an account of the need, in his Monmouthshire district, for such instruction as was proposed in the papers read, and of the work being done there.

Paper on "County Organisations for Teaching Branches of Domestic Economy," was read by the **Rev. Newton Price, M.A.**

Mr. Stephen Mitchell said that the method of teaching by books was at fault. Papers were sent in to the Science and Art Department in great numbers, but, though without any outward distinctions, they could be traced to particular schools by internal evidence, from containing the same mistakes and the same kind of blunders, showing that the children did not know what they were writing about, but that they were simply copying from text-books, without any knowledge of method or principle. He, therefore, deprecated the use of books for the children, though they would be useful for teachers; and the children should be shown how they could do things for themselves. With regard to the remark that while some ladies were able to work successfully, others rashly following them only exposed themselves to ridicule, that result simply arose from the ladies not knowing what they were teaching.

Mr. Kempson said it was very satisfactory that girls were being taught domestic economy in the schools, and with good results, but he also thought boys should be taught social and political economy as kindred subjects.

Mrs. Gover advocated the claims of factory girls to instruction of this kind. Thousands of them would as readily attend classes for their benefit as they would go to penny readings. Evening classes might usefully be established, as the Factory Acts compelled a cessation of labour at eight o'clock.

Miss Kenrick thought a divided inspectorship would not be so satisfactory as the present system. It was a mistake to suppose every woman knew something about sewing; and some who undertook that important branch of instruction were anything but competent to do so.

The instruction of very young children should be left to women; but it was a very different thing to say that they should be entrusted with all examinations, though ladies might properly be appointed to assist the inspectors in the examination of needlework, and such matters with which a man could not be so well acquainted. Confusion only would result from the appointment of two sets of inspectors, and an over amount of work would be extracted from the children. Cookery was not a subject which could be examined on, or made a means of obtaining a Government grant, but should rather be taught so as to be brought into the children's homes. Principles should be instilled into their minds by the help of experiments; and the girls' homes would then benefit by their teaching. Half the battle would be won, when once the children's minds were interested.

Sir Henry Cole agreed that very young children were better taught by women than by men. The two formidable words, "domestic economy," simply meant "home life," the knowledge of which should be inculcated (as it did, in fact, begin from the earliest age at home) before reading, writing, and arithmetic were taught; cleanliness was not a matter for text-books or physiological diagrams.

Miss Guthrie Wright said this Congress had particularly to do with the subject of teaching domestic economy in public elementary schools. Such instruction was as necessary for the higher as for the working classes, and if good examples were shown by the upper and middle classes, the subject would be much more popular and acceptable to the working classes, than if pushed among the latter exclusively. At the school in Edinburgh, the object arrived at was to teach subjects which could be made useful at home. That, of course, presented a very wide field for future work, and included sanitary teaching alike for rich and poor. The recognition of elementary teaching in the Code was only a matter of time; but in private schools considerable attention had been given to it, and the managers had been induced to take it up. Public attention in this direction was much required. More than was really possible to teach, in the shape of languages, drawing, and music, was expected from girls before leaving school, and it would be well if domestic economy were made, to a considerable extent, a substitute. Three subjects might be practically taught, cookery, laundry work, and cutting out clothes. A great deal of good had been done by the public cookery classes for older persons, and homely teaching could also be given at mothers' meetings, care being taken to leave out all technical expressions on the scientific part of the question.

Dr. Mann said that this Congress would be specially valuable if it should succeed in bringing before the public the great necessity for women doing women's work. He did not think ladies had ever before taken so much practical interest in these matters as they were doing now, and hoped this was but the first of a series of meetings which would show they could work for that object.

Miss Fanny Calder said that it had been found in the North of England that cookery could not be taught theoretically, and they had been considering how they could best teach and examine upon it practically. Grants for practical work of that description had been applied for, and Mr. Mundella promised to give the matter full consideration. Where the teaching had been theoretical it had been unsatisfactory. The inspectors had recommended that some plans should be devised for the adoption of new practical methods, in connection with South Kensington.

Paper read by **Dr Mann**, on "Domestic Economy, Defined and Arranged for Elementary School Teaching."

Mrs. Fenwick (member of Yorkshire Ladies' Council of Education, and hon. sec. York County School of Cookery) advocated the appointment of lady inspectors for schools in domestic economy subjects, as men who had had a classical education could not be expected to acquire the necessary knowledge of cookery and needlework. Influence should, therefore, be brought to bear on the Government to appoint properly qualified lady inspectors.

Miss Phillips referred to the reluctance of persons to attend classes, and urged that girls should not be confused by too many subjects being brought before them.

Mr. Chadwick was an advocate for women doing women's work, and said the best work was done in schools which had female teaches. A great advance would be made by substituting for the teaching of childless wranglers, that of ladies who were well accustomed to the work of their own families.

A paper was read by **Miss Andrews**, on "The Need of Domestic Economy in the bringing up of Pauper Children."

Mr. Chadwick remarked, on the question of waste, that on visiting a pauper school he had found a prize pig being fed on the waste from the tables. At St. Pancras Workhouse there were cooking ranges and washing apparatus established, and everything had been systematised, with the result that 90 per cent. of the children now got good situations, against one-third formerly.

The meeting then adjourned for luncheon.

On the re-assembling of the meeting, **Mrs. Bidder** took the chair.

Mrs. Barnett read Mrs. Greenup's paper, on "The Teaching of Domestic Economy in Schools."

Sir Henry Cole said it was mere pedantry to think that people could go through the world with all the virtues, if they knew nothing about how to practice them. It was fallacious to hold, according to the Code, that until children had passed the fourth standard they were not to be taught cleanliness, thrift, and economy. He inquired of Lady Stanley of Alderney whether she was not of opinion that children three years old might not be taught something of domestic economy before they knew anything of reading, writing, and arithmetic.

Lady Stanley of Alderney thought it would be no use teaching sewing and needlework at such an age, and considered children would be much better employed rubbing their fingers in perfect liberty. Four years of age was quite early enough for children to go to school.

Miss E. M. Brant (Board School, Great Berkhamstead, Herts) read a paper on "Method of Teaching Domestic Economy."

Sir Henry Cole thought that if young people went through such instructions as was advocated in the paper, girls taking domestic situations would be better prepared to fill them than at present.

Mrs. Ross (manager of a London Board School) having spoken in favour of such instruction,

Mr. Alsager Hay Hill deprecated mere theoretical teaching, and suggested the promulgation of practical suggestions in the cheap popular newspapers and periodicals.

The Rev. E. F. M. McCarthy's paper, "Examination and Inspection in relation to Domestic Economy," was read by the **Rev. J. P. Faunthorpe.**

Mrs. Rowland Williams read a paper on "The Code and Domestic Economy." (Second Branch.)

Mr. Faunthorpe protested against wholesale condemnation of theoretical and the exclusive advocacy of practical teaching. The mistresses leaving the training

college need not necessarily know anything of cookery, and practical qualifications should be demanded of the teachers before they were required of the children.

Sir Henry Cole read a paper on "Teachers' Certificates of Competency."

Miss Harriett Martin read a paper on "Domestic Economy in Schools and Training Colleges."

Mr. William J. Harrison's (F.G.S.) prize paper, "The Itinerant Method of Teaching Domestic Economy in Public Elementary Schools," was read.

Miss Becker disliked class legislation, that would make obligatory on the poor the acquirement of knowledge such as cookery, needlework, and general domestic economy, which was not demanded of the rich. At present the compulsory education imposed was obligatory alike on all.

Mrs. Fenwick urged that the teaching in these subjects should be both practical and theoretical, and should be imparted according to age, and not by standards, in order to reach dull girls.

Mrs. Charles differed from Miss Becker's views on class legislation.

Mr. Alcock and the **Rev. J. P. Faunthorpe** added a few confirmatory remarks, and the meeting terminated.

The meeting of Wednesday, 22nd June, was held at the Royal Albert Hall, at 11 a.m., the Countess SPENCER in the chair, and the Rev. NEWTON PRICE, assessor.

SECTION B.—NEEDLEWORK.

Mrs. Stanley read a paper on "Needlework Certificates for Teachers."

Madame Guizot de Witt's paper, on "The State of Needlework in the Primary Schools of France," was read by **Miss Mallett.**

Miss Kenrick spoke specially in reference to needlework done in Birmingham Board Schools, and pointed out the necessity of teaching the art of cutting out without waste. She had found children in the first standard, about seven years of age, able to knit stockings. Coloured materials in work might be used with advantage, and in other ways a great deal might be done to make the children's work "pretty" for them. One of her experiments was having a number of cheap dolls dressed by the children of standards 4, 5, and 6, and she suggested that it would be a temptation to girls to go on with their work if one of the dolls was given in each school as a prize for the best work. To possess a doll, a child would, she believed, work steadily for a year.

A Lady recommended that boys in infant schools should be taught to use the needle, and learn to sew and knit as well as the girls. Little boys got very tired while the girls were sewing, and the only resource was to give them their lessons to do over again. She had herself taught boys as young as 2½ years to knit, making the inducement to them to learn that they might sit up instead of going to bed, as they would have to do if they did not learn to do something to occupy their fingers.

Rev. Newton Price was requested by Lady Airlie to state that a coachman in her employment was able to, and did, knit all the stockings for his family. He quite agreed in the desirability of boys being taught generally arts so useful.

Mrs. Cromwell gave an instance of a school in Devonshire where the boys were so instructed with advantage.

Rev. Newton Price said that in the Duchess of Leeds' schools prizes were given for such work; and, on the whole, the work done by the boys was superior to that performed by the girls.

Lady Stuart Hogg called attention to a remark by M. Le Gouvet, a great authority on educational matters in France, on the apparent inability of peasant men to find any occupation in the evenings beyond idly smoking; and the utility of giving them a means of employing their leisure in needlework of some kind.

Mrs. Dacre Craven remarked that in the Franco-German war, the Germans in hospital were able to occupy themselves usefully with the needle, while the French had great difficulty in passing the long hours. It would be well if boys in English schools were taught to sew and knit as in the German schools.

Rev. Newton Price said that one result of this Congress would be a recommendation to the authorities of the Educational Department in favour of the instruction of boys in these matters.

Miss Sempill's paper on "Simultaneous Teaching of Needlework" was read.

Rev. Newton Price gave an instance, on the authority of a lady present, of an old soldier having made, of his own design, from silk cuttings, a very fine patchwork quilt, which afterwards received the approval of the Duchess of Edinburgh.

Miss Cole's paper, "Notes on Clothing and Dress," was read by **Miss Stanley.**

Miss Kenrick suggested that the children should be put through examinations as to the amount and quality of the materials required to be made up into garments, and said that interspersing the lessons with questions for that purpose would enliven the dulness of the work. It was very desirable that children should be taught to combine colours tastefully, and so avoid the discordant results of ill-selected and badly arranged finery. Boys she could not admit to be quite so clever with the needle as they had been represented, but still much might be done in teaching them.

Miss Stanley offered a few remarks on the inculcation of ideas of suitability in dress to height, figure, and occupation. Students should be carefully instructed in those matters, and teachers should avoid appearing unnecessarily ornamented in their work.

Mrs. Floyer urged the necessity of a good example being set in matters of dress by teachers to the children in their charge.

Paper by Madame Van Eyck-Hardamann, read by **Miss Mallett,** "The Teaching of Plain Needlework in the Netherlands."

A Lady objected to so much time as six hours being given in the last standard to instructing girls who might be urgently wanted at home, and thought four hours would be sufficient.

Rev. Fredk. Lawrence (secretary to the Church of England Mourning Reform Association) offered a few remarks on the objects of that body, for which he asked support, and said that one of its objects was the abolition of crape for ladies as a sign of mourning.

Mrs. Erskine's paper, "Notes on Teaching of Needlework in Elementary Schools," was read by **Miss Stanley.**

Miss Curry's Paper, "How I Teach Sewing," was read by **Miss Webb,** and the meeting adjourned.

On the re-assembling of the meeting, a lecture was given by **Mrs. Floyer,** Demonstrator in Plain Needlework to the London Institute for the Advancement of Plain Needlework.

Mrs. Floyer said, with regard to the simultaneous teaching of needlework, as reading, writing, and arithmetic had for many years been taught in that way, it had occurred to her that the same method might advantageously be used in respect to needlework. The

question was, how was it to be done, and the first thing necessary was the adoption of a simple plan for avoidance of waste, and to render tools unnecessary as far as possible, the teacher always having the whole class at command. With the object of simplification, the method of hemming, for instance, had been reduced to six movements, and instead of being allowed to move their fingers in any way they pleased, they were instructed in position drill for their hands. This kind of instruction at once rendered children constructing, and not merely consuming, members of society. Specimens of work done after short periods of teaching were then referred to and explained. On the next subject of knitting much needless difficulty had been occasioned in teaching children, and they could be easily taught to do for themselves what was often done for them by teachers, in the shape of "casting on" and in other ways. Explanation was then given on the blackboard of a system for demonstrating proper modes of taking stitches, thus giving the children definite standards to work by. The great bugbear of teaching was how to teach classes of sixty or seventy children the way to cut out, in the absence of materials for them all. It had, therefore, been thought advisable to utilise the kinder-garten principle of using chequered slates, and it was found that the children had no difficulty in extending their work from the patterns after every three lessons. A great difficulty was to keep children clean who came from the poorest homes, and, in view of that fact, the cleanly appearance of the work shown was very creditable to the teachers. The importance of drill among children was really hardly understood. Teachers should recognise the necessity of self-drill in the first place, and its results would show themselves in the condition of their schools. Boys should be taught needlework as a means of giving them greater facility in the use of their fingers —a much needed requirement for them—for it was a common and true saying that "their fingers were all thumbs." Old copy-books might be used for making patterns. More specimens were then referred to, and the work analysed as showing the efficacy of the simultaneous plan of teaching. The most earnest application by the children was often stultified by the failure of their teachers to supply them with proper standards.

Paper read by the **Hon. Albertine Grosvenor**, on the "Watford and West Herts Association for the Improvement of Elementary Needlework in Schools."

Rev. Newton Price said formerly there was a great want of faith in the power of the inspectors' power of judging needlework, and teachers had candidly admitted that, until the association came into existence, needlework was very much neglected by them, knowing the inability of the inspectors to understand it, in favour of other subjects which would do them more credit, but since the efforts of the association had been pointed in this direction, the great progress made had astonished the managers.

Miss Phillips read a paper on "Needlework."

A Lady remarked that a great deal had been said about what was being done for the women of the future, and said she would be glad to hear what was being done for the grown-up women of the present.

Miss Allen read her prize paper, "Instruction in Needlework."

The evening meeting on Wednesday, 22nd June, was held at seven o'clock, at the House of the Society of Arts, when the chair was taken by Mrs. Mann, Sir H. Cole acting as assessor.

Section A.—Food: Its Composition and Nutritious Value; its Functions.

A paper, by Miss Buncle (Dumbarton), on "How I Teach Practical Cooking," was read by **Miss Yates.**

Sir Henry Cole said this lady had received one of the eight prizes awarded by the Society for a paper on the teaching of cookery.

The Rev. Nugent Price said a circular had been sent to her Majesty's inspectors with regard to the instruction given in cookery and domestic economy, the matter having been very slightly dealt with in the Blue-book. When the results had been analysed and arranged, it was intended to lay them before the Education Department. Cookery was now taught in 300 schools, including all the large towns except Manchester. The inspectors themselves seemed very favourable to the teaching of this subject, but he was sorry to find that some ladies would prefer that children should be taught drawing or philosophy. He hoped that every effort would be made to keep down the expense of teaching cookery, and no attempt be made to turn out cooks fit for rich men's establishments. He was proud to say he was the first to introduce this subject into a public elementary school.

Sir Henry Cole said some years ago they prevailed on a Government Inspector to visit the School of Cookery, and he was much shocked at finding the children were taught to clean pots and pans. This gentleman was the author of the phrase "Culinary Treatment," in place of cooking, but he hoped it would soon give place to the proper term.

Miss Harriet Martin next read a paper on "Some Points Considered in Teaching the Second Branch of Domestic Economy," explaining in detail the method of instruction followed in Whitelands College, Chelsea.

Sir Henry Cole thought the teaching of teachers was carried out more perfectly at Whitelands than anywhere else.

Dr. Mann wished to draw attention to the fact that this paper referred especially to the education of teachers. For many years he had been acquainted with this college, and it was quite marvellous what results were obtained there in a course of two years.

Dr. Frances Hoggan said, in listening to the list of dishes mentioned, she had been sorry to miss vegetable dishes, especially as many of the teachers were going to neighbourhoods where there would be a large amount of vegetable food at command. It was quite possible to obtain everything requisite to build up the body and repair waste from the vegetable kingdom alone, and it was, therefore, of great importance that this branch of cooking should receive due attention. 2,500 vegetarian dinners were now given annually in London, and there was great difficulty in finding cooks competent in this branch. It would be desirable, therefore, that where a sufficient class could be formed, a teacher of vegetarian cookery should be specially engaged. She was a great advocate for simplicity in everything, and preferred the terms nitrogenous and non-nitrogenous foods in place of the distinctions of flesh-forming and heat-producing, which recent researches had shown could not always be maintained.

Miss Martin admitted that it was an omission not to have mentioned the cooking of vegetables, but it was simply for the want of space. All the girls were taught how to boil a potato. She preferred the terms combustible or non-combustible, or oxidisable and non-oxidisable, as physiological terms, to chemical ones.

Miss Barnett imagined that what vegetarians required was something more than the proper cooking of a potato. She had frequently been asked for lessons in producing a variety of vegetarian dishes, and had given them.

A paper on "A Method of Teaching Cookery," by **Miss Clive Bayley**, was next read.

Sir Henry Cole said this subject of culinary treatment had now been in public documents for some years, but there were only two places where female teachers could be taught cooking, and the department did not even insist that teachers should have a knowledge of cooking.

Miss E. Barnett next read a paper on "Cookery and Cookery Teachers."

Sir H. Cole said there were several points of great importance in this paper. It was very important that a teacher of cookery should be well educated, but he did not know how that was to be secured.

A Lady suggested that a common kitchen as well as a laundry should be placed at the top of model lodging houses. It would be a great benefit if the rich would take care that the liquor in which poultry or meat was boiled were given to the poor, instead of being thrown down the sewers.

Mrs. Mann next read a paper on "The Economical Establishment and Management of School Kitchens."

A paper on "Domestic Cookery, as Taught to the Children of a Voluntary School," by **Mrs. Debenham**, was next read.

Mr. Alan S. Cole then read a paper on "The Philosophy of Cookery."

Miss Guthrie Wright wished to remark that all connected with schools would agree with Mrs. Mann that cookery should be taught practically, and, as a rule, she believed it was taught in that way. In Edinburgh, they had not a special kitchen, and endeavoured to make the conditions as nearly as possible parallel to those which obtained in their own homes. Strict attention was paid to economy of material, the object being not to make cooks, but to improve the cooking in the homes of the poor. Pulses were paid much attention to. The lessons consisted of twelve demonstrations, and were given to girls of 12 years old, and to those who had passed the fifth standard. Boys were also allowed to attend in some cases. The teaching of Cookery in Training Colleges was of very great importance. It was very important to select women of good education for teachers of cookery: she did not see how anyone else could teach it properly.

Sir Henry Cole said a book might be bought for 1s. which would show how to teach a child of four years of age the rudiments of cooking, which he would recommend to the attention of the meeting. He explained some of the details which could be very easily conveyed to a young child's mind, and the practical operations in which they might take part. The title of the book was "Handbook of Home Life." He had to state on behalf of a Diocesan Inspector that £5 was quite sufficient expenditure for utensils if some sort of cooking range were at hand. He believed cookery teaching often failed from attempting too much.

The next paper was on "The Importance of Teaching Children the Great Benefits to be derived from the Use of Whole-meal Bread," by **Miss Yates**.

Mrs. Fenwick thought the whole subject of domestic economy should be taught, not cookery alone. In Yorkshire they endeavoured to teach the whole subjects connected with it except washing, to which they had not yet attained. She suggested that the whole subject should be considered necessary to the training of teachers of cookery, as the whole was connected together. She gave details of the manner in which cookery was taught and the utensils which were employed.

Mr. W. S. Mitchell read a paper on "The Food Collection at Bethnal-green," and the advantages to be derived from a study of it.

After a few remarks from **Mr. Clements**, the Conference adjourned until Thursday morning at eleven o'clock.

MISCELLANEOUS.

GAS FOR LIGHT AND HEATING.

On Tuesday, June 14, Dr. C. W. Siemens, F.R.S., read a paper before the conference of gas managers held at Birmingham, on "Gas Supply, both for Heating and Illuminating Purposes." When, within the memory of living men, the gas-burner took the place of the oil-lamp, the improvement was so great that the ultimate condition of perfection appeared to have been reached. It is only in recent years that much attention has been bestowed upon the utilisation of by-products with a view of cheapening cost, and that the consumer has become alive to the importance of having a gas of high illuminating power, free from nauseous constituents, such as bisulphide of carbon, thus providing a stimulant for progress on the part of the gas-works manager. This condition of things has been rudely shaken by the introduction of the electric light, which, owing to its greater brilliancy and cheapness, threatens to do for gas what gas did for oil half a century before. The lighting of the City of London and of public halls and works furnishes proof that the electric light is not an imaginary, but a real competitor with gas as an illuminant; and it is indeed time for gas engineers and managers to look seriously to their position with regard to this new rival. For my own part (Dr. Siemens said), I present myself before you both as a rival and a friend—as a rival, because I am one of the promoters of electric illumination; and as a friend, because I have advocated the use of gas for heating purposes during the last 20 years, and am not disposed to relinquish my advocacy of gas both as an illuminating and as a heating agent. Speaking as a gas engineer, I should be disposed to regard the electric light as an incentive to fresh exertion, confidently anticipating achievements by the use of gas which would probably have been long postponed under the continued *régime* of a monopoly. Already we observe, thanks chiefly to Mr. Sugg, both in our thoroughfares and in our apartments, gas-burners producing a brighter light than was to be seen previously; and although gas will have to yield to the electric light the illumination of our lighthouses, halls, and great thoroughfares, it will be in a position, I believe, to hold its own as a domestic illuminant, owing to its convenience of usage, and to the facility with which it can be subdivided and regulated. The loss which it is likely to sustain in large applications as an illuminant would be more than compensated by its use as a heating agent, to which the attention of both the producer and the consumer has latterly been largely directed. Having, in the development of the regenerative gas furnace, had opportunities of recognising the many advantages of gaseous over solid fuel, I ventured, as early as 1863, to propose to the Town Council of Birmingham the establishment of works for the distribution of heating gas throughout the town; and it has occurred to me to take this opportunity (when the gas managers of Great Britain hold their annual meeting at the very place of my early proposal) to lay before them the idea that then guided me, and to suggest a plan of operation for its realisation which, at the present day, will not, I hope, be regarded by them as Utopian. The proposal of 1863 consisted in the establishment of separate mains for the distribution of heating gas to be produced in vertical retorts, that might be shortly described as Appold's coke ovens, heated by means of "producer" gas and "regenerators." The Corporation applied for an Act of Parliament, but did not succeed in obtaining it, owing to the opposition of the gas companies, who pledged themselves to carry out such an

undertaking, if found feasible by them. I am ready to admit that at the time the success of the undertaking would have involved considerable difficulties; but I feel confident that the modified plan which it is my present object to bring before you would reduce these difficulties to a minimum, and would open out a new field for the enterprise of those interested in gas-works. The gas-retort would be the same as at present, and the only change I would advocate in the benches is the use of the regenerative gas-furnace. This was first successfully introduced by me at the Paris Gas-works in 1863, and has since found favour with the managers of gas works abroad, and in this country. The advantages that have been proved in favour of this made of heating are—economy of fuel; greater durability of retorts, owing to the more perfect distribution of heat; the introduction of an additional retort in each bed, in the position previously occupied by the fire-grate; and, above all, a more rapid distillation of the coal, resulting in changes of four hours each, whereas six hours are necessary under the ordinary mode of firing. The additional suggestion I have now to make, consists in providing over each bench of retorts two collecting pipes, the one being set aside for illuminating and the other for a separate service of heating gas. I shall be able to prove to you, from unimpeachable evidence, that the gas coming from a retort varies very greatly in its character during progressive periods of the charge; that during the first quarter of an hour after closing the retort the gas given off consists principally of marsh gas (CH_4) and other gases and vapours, which are of little or no use for illuminating purposes; from the end of the first quarter of an hour, for a period of two hours, rich hydro-carbons, such as acetylene (C_2H_2) and olefiant gas (C_2H_4) are given off; whereas the gases passing away after this consist for the most part again of marsh gas, possessing low illuminating power. According to the figures given in the experiment of M. Ellissen, President of the French Society of Gas Engineers, it appears that nearly two-thirds of the total production of gas takes place in the above period, while the remaining third is distilled during the first quarter of an hour and the last hour and three-quarters. It hence follows that by changing the direction of the flow of gas at the periods indicated, allowing the first results of distillation to flow into the heating gas main, then for two consecutive hours into the illuminating gas main, and for the remainder of the period again into the heating-gas main, one-third volume of heating and two-thirds of illuminating gas would be obtained, with this important difference, that the illuminating gas would be of 16·16 instead of 13·5 candle power, and that the heating gas, although possessed of an illuminating power of only 11·05 candles, would be preferable to the mixed gas for heating purposes in being less liable in its combustion to deposit soot upon heat-absorbing surfaces, and in giving, weight for weight, a calorific power superior to olefiant gas. The working out of this plan would involve the mechanical operation of changing the direction of the gas coming from each bench of retorts at the proper periods of the charge. In order to distribute the two gases a double set of gas mains would certainly be required, but these exist already in the principal thoroughfares of many of our great towns, and it would not, I think, be difficult to utilise them for the separate supply of illuminating and heating gas, the latter being only taken into the houses and establishments where it is asked for by the occupiers. The public could well afford to pay an increased price for a gas of greatly increased illuminating power, and the increase of revenue thus produced would enable gas companies to supply heating gas at a proportionately reduced rate. The question may be asked whether a demand would be likely to arise for heating gas similar in amount to that for illuminating gas; and I am of opinion that, although the present amount of gas supplied for illuminating purposes exceeds that for heating, the diminution in price for the latter would very soon indeed reverse these proportions. Already gas is used in rapidly increasing quantities for kitcheners, for the working of gas-engines, and for fire-grates. As regards the latter application, I may here mention that an arrangement for using gas and coke jointly in an open fireplace combined with a simple contrivance for effecting the combustion of the gas by heated air, has found favour with many of the leading grate builders and with the public. As regards the use of illuminating gas, I have one more suggestion to make, which I feel confident will be viewed by you with interest. The illuminating effect produced in a gas flame depends partly upon the amount of carbon developed in the solid condition in the body of the flame, and partly upon the temperature to which these particles are heated in the act of combustion. Having shown how by separation a gas of greater luminosity may be supplied, it remains to be seen how the temperature of combustion may be raised. This may be effected by certain mechanical arrangements, whereby a portion of the waste heat produced by the flame itself is rendered available to heat the gas and air sustaining the combustion of the flame—say to 600° Fahrenheit, or even beyond this point. The arrangement I have adopted for this purpose is a burner of the ordinary Argand type, mounted in a small cylindrical chamber of sheet copper, connected with a vertical rod of copper, projecting upwards through the centre of the burner, and terminating in a cup-like extension at a point about four inches above the gas orifices, or on a level with the top of the flame. A small mass of fire-clay fills the cup, projecting upwards from it in a rounded and pointed form. The copper vessel surrounding the burner is contracted at its upper extremity with a view of directing a current of air against the gas-jets on the burner, and on its circumference it is perforated for the admission of atmospheric air. The bottom surface is formed of a perforated disc covered with wire gauze, and wire gauze also surrounds the circumference of the perforated cylinder. The external air is heated in passing through these "regenerative" surfaces, and the flame is thus fed with air, heated to the point above indicated, which, by more elaborate arrangements, might be raised to a still higher degree. The ball of fire-clay in the centre of the burner, which is heated to redness, serves the useful purpose of completing the combustion of the gas, aud thus diminishes the liability to blackening of the ceiling. The arrangement for transfering the heat from the tip of the flame to the air supporting its combustion was applicable also to an open bat's-wing burner, but I have not yet had time to ascertain accurately the amount of increase of luminosity that may be realised with this class of burner. From a purely theoretical point of view, it can be shown that of the caloric energy developed in the combustion of gas a proportion (probably not exceeding 1 per cent.) is really utilised in the production of luminous rays; and that even in the electric light nine-tenths of the energy set up in the arc is dispersed in the form of heat, and one-tenth only is utilised in the form of luminous rays. It would lead us too far here to go into the particulars of these calculations, but it is important to call attention to them in order to show the large margin still before us for practical improvements. I may here mention that another solution of the problem of heating the incoming air by the waste heat of the products of combustion has lately been brought under public notice by my brother, Frederick Siemens, which differs essentially from the plan I have suggested, inasmuch as he draws the flame downwards through heating apparatus, and thence into a chimney. In practice both these methods of intensifying a gas flame will probably find independent application, according to circumstances. By the combined employment of the process for separating the illumination from the heated gas with the arrangement for intensifying the luminosity

of the gas flame, the total luminous effect produced by a given consumption of coal gas may, according to the figures given, be increased threefold, thus showing that the deleterious effects now appertaining to gas illumination are not inseparable from its use. My principal object in preparing this communication has been to call your attention generally to the important question of an improved gas illumination, and more particularly to the subject of a separate supply for heating gas, which, if carried into effect, would lead, I am convinced, to beneficial results, the importance of which, both to gas companies and to the public, it would be difficult to over-estimate.

THE CULTIVATION OF LAND IN KAZEROON (WESTERN PERSIA).

All land in Kazeroon is private property. If the cultivation be undertaken by the landowner himself, he has to provide seed for an acre of one "gao" of cultivation (the "gao" representing the extent cultivable with one ox), viz., 1,000 lbs. of wheat and 1,000 lbs. barley, and pay about 14 krans (the kran being equal to 11d.) for the labour of ploughing and sowing. He pays in kind 11 per cent. of the yield of his harvest to Government, and 20 per cent. to the reapers, who have to undertake all the duties appertaining to the collection of the harvest and the carriage into the stores of the landlord. The landowner also pays 2 to 4 per cent. for threshing or treading the corn. Other than a landowner undertaking a cultivation has to pay to the landowner 9 per cent. in kind from the out-turn of his harvest as rent for one "gao" of land, and 14 per cent. to the Government as tax; his other expenses are the same as those incurred by a landowner. Consul-General Ross states that the agriculturists of Kazeroon are of two classes, viz., the "ryot-i-padishah" and the non-ryot, the former being always looked down upon by all classes, and subjected by Government to more oppression than the others. The ryot cultivator thus not only pays more taxes to Government, but has to pay his taxes in cash instead of in kind, and at 30 per cent. above market value. He is also obliged to give a certain quantity of straw to Government officials whenever required. A ryot, when a landowner, and cultivating his own grounds, has to pay 15½ per cent. on his harvest in cash, and at the above enhanced valuation. A poor ryot pays about 60 krans annually in cash to Government; and there is another class of ryots who are obliged to buy at 30 per cent. above market value, a certain portion of the produce received by Government as taxes. A wealthy ryot is entirely at the mercy of the authorities, a sum of about 1,000 krans being annually levied from him. The value of one "gao" of land is from 100 to 600 krans, according to the locality. To commence cultivation, an outlay of about 15 tomains (the tomain being equivalent to 9s. 3d.) is necessary, and is distributed as follows:—One ox, 50 krans; seed, 60 krans; labour, about 14 krans; straw and cotton seeds, 16 krans; and sundries, 10 krans. It is also necessary for a ryot when undertaking four or more "gaos" of cultivation, to maintain at least one donkey. The quantity of grain required for cultivating one "gao" of ground is about 2,000 lbs. In the case of "saifee" or summer cultivation, no distinction is made by Government between a ryot and a non-ryot; "saifee" sowings are always undertaken by proprietors of water and agriculturists conjointly, the proprietor providing the water and ground, and the agriculturist finding the seed, labour, implements, &c. Should the water owner, however, not be a landowner as well, any other landowner would be but too glad to permit his lands to be used for "saifee" cultivation gratis, inasmuch as the soil becomes enriched by manuring, which the "saifee" cultivation necessitates. The time taken for "saifee" sowing is about seven months, the following being cultivated — tobacco, water melon, marsh melon, vegetables, cotton, sesame seeds, lentils, rice, gram, &c. A tax of 20 per cent., *ad valorem*, on the out-turn, is levied by Government, three-fifths of which is payable by the proprietor of the water, and two-fifths by the cultivator, and the balance is equally divided between the proprietor and the cultivator. Rice and grain, however, form an exception, and are cultivated under the following conditions:—The agriculturist recoups himself for the quantity of seed supplied by him after harvest. He then has equal shares with the water owner, who alone pays Government taxes as follows: — If a ryot, he pays three-fifths of his share to Government; if a non-ryot, he pays only half, the agriculturist paying no tax on his share. In all cases it is thoroughly understood that the Government share of the produce is to be carried to Government store at the cultivator's expense. The approximate value of the produce on the spot is for wheat, from 40 to 60 cents. per maund (the maund being equivalent to 3 lbs. avoirdupoids); barley, from 25 to 30; gram, from 50 to 80; sesame, from 70 to 100; maithee, from 15 to 20; dhall, from 15 to 20; cotton, from 2½ to 3 krans; and rice, from 50 to 80 cents. The annual expenses of a ryot cultivator in Kazeroon, with a wife and two children, are 10 tomains per annum. The yield of wheat and barley is from ten fold to twelve fold in a good year, and three fold to four fold in a bad one; rice, in a bad year, yields twenty fold, and in a very good year, sixty fold; cotton, five fold in a bad year, and ten fold in a good year. Irrigation is generally conducted by means of kanats, and the water in all cases is allowed free passage across grounds, even though not belonging to the proprietor of the kanat; should the proprietor of a kanat not wish to undertake any "saifee" cultivation, he could still be made liable by Government to such taxes as may be due by the cultivator; no taxes whatever are levied on gardens in Kazeroon. In the cultivation of the poppy, which is largely grown, the proprietor provides the land, seed, and the expenses of sowing, the cultivation is then made over to the ryot, who undertakes all the labour necessary for the tending of the crop till the season of cultivation, when the proprietor pays for the labour of incision, about one kran per man per day; the out-turn is then equally divided between the landowner and the ryots. The cultivation of opium is also untaxed. A good deal of water is wasted in Persia owing to the long distances it has very often to travel before reaching a land eligible for its security against raids, &c., and to damages constantly sustained by watercourses, which, owing to the social conditions of the country, it is very often beyond the reach of the ryot to travel out of the jurisdiction of his village to repair. There are also large tracts of fertile land which remain waste owing to their proximity to the main roads, as no village having cultivators on such spots can possibly prosper or enjoy the least immunity from the exacting demands of Government officials, and the thefts and robberies committed by the "Iliyat" tribes on their passage along the country thoroughfares.

NOTES ON BOOKS.

Melbourne International Exhibition, 1881. The Official Catalogue of the Exhibits, with the Introductory Notices of the Countries Exhibiting. Melbourne, 1880. 2 vols., 8vo.

This is a second edition of the catalogue, and contains a complete record of the exhibits. The general classification adopted consisted of 82 classes in ten groups:—

Group 1. Works of art; 2. Education and instruction, apparatus and process of the liberal arts; 3. Furniture and accessories; 4. Textile fabrics, clothing and accessories; 5. Raw and manufactured products; 6. Machinery, apparatus and processes used in the mechanical industries; 7. Alimentary products; 8. Agriculture; 9. Horticulture; 10. Mining industries, machinery and prducts. Prefixed to the list of exhibits of each Court is a statistical account of the country which sent them.

GENERAL NOTES.

National Training School of Music.—A series of students' concerts is now being given in the arena of the Albert Hall. Future concerts will be on the afternoons of Wednesday, June 29, Friday, July 8, Wednesdays, July 3, and 20, commencing at 4 p.m. The public will be admittted to these concerts on payment of 1s., but students will be supplied with tickets for their friends gratis.

Ecclesiastical Art Exhibition at Newcastle.—An Exhibition of Ecclesiastical Art will be held at Newcastle-on-Tyne during the meeting of the Church Congress from October 3 to 8. The Exhibition will include articles of every description used in the building and adornment of churches, or in connection with the services thereof—stone and wood carving, stained glass, brass and metal work, gold and silver plate, bells, embroidery, tapestry, organs and harmoniums, church chairs, mosaics, &c., a large gallery being set apart for the display of cartoons, designs, pictures, architectural drawings, &c. It has been decided to admit also all kinds of school applicances, books, &c., useful in the furtherance of education. There will be also an extensive loan collection of pictures, photographs, designs (old and new), embroidery, carvings, and objects of ecclesiastical art generally. Applications for space, or permission to exhibit, should be addressed to Mr. J. Hart, manager, Ecclesiastical Art Exhibition, 33, Southampton-street, Strand, London, W.C.; or Mr. G. J. Baguley, 45, Carliol-street, Newcastle.

Gold in the United States.—According to a report of the Director of the United States Mint lately issued, the total gold circulation of the United States, including bullion in the Treasury, amounted, at the commencement of May, to 520,000,000 dollars, of which about 264,000,000 dollars was held as Treasury and national bank reserves, and 256,000,000 dollars was in actual circulation. There has been a total gain of gold coin and bullion to the country since July, 1879, of 234,000,000 dollars, of which 35,000,000 dollars was added to the Treasury, 59,000,000 dollars to the banks, and 140,000,000 dollars to the active circulation. The total amount of gold in the country makes a fair showing compared with the principal countries of Europe, being exceeded by only two. The amount estimated to be in England in 1880 was 596,000,000 dollars, of which 428,000,000 dollars was in actual circulation; and France, with 927,000,000 dollars of gold, had a circulation of about 816,000,000 dollars. The larger proportion of gold in active circulation in the latter two countries the director attributes in part to the fact that their coinage consists most exclusively of denominations of less value than 5 dollars. The largest English gold coin is the sovereign, equivalent to 4·86½ dollars of American money, while in France, out of a total coinage during the last 77 years of 1,743,288,000 dollars of gold, nearly 99 per cent. was in pieces of less than 5 dollars.

Oyster Culture in Tasmania.—A successful attempt to breed oysters in a bed specially prepared for their reception appears to have been made in Tasmania, at a place bearing the appropriate name of Little Oyster Cove, where a number of these bivalves were placed towards the end of last year, in the expectation that they would "spat" or spawn in the month corresponding to the month of July, which is the breeding season of the European oyster. It was not, however, till the middle of February that the usual symptoms of a "heavy fall of spat" were observed, the water being seen to be full of the minute oysters just extruded from the parent shells. In March an examination was made of the fascines which had been placed to collect the young molluscs, and they were found to be thickly covered with minute oysters. If any reasonable proportion of these molluscs come to maturity, there is every prospect of the science of oyster culture being carried out in a most successful manner in Tasmania. The total number of young oysters born last February in Little Oyster Cove is variously estimated to have been from 2,500,000,000 to 40,000,000,000. If but one per cent. come to maturity and market four years hence, the enterprising Colonist who conducted the experiment ought to reap a rich reward.—*Colonies and India.*

MEETINGS FOR THE ENSUING WEEK.

Monday, June 27th...Anglers' Association (at the House of the Society of Arts), 8½ p.m. Conference on the Fresh Water Fisheries Act.

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Lieut.-Colonel C. E. Stewart, "The Country of the Tekke Turkomans and the Tejend and Murghab Rivers."

Public Analysts, Burlington-house, Piccadilly, W., 8 p.m. Special General Meeting to Consider Alteration of Rules. 1. Mr. A. Wynter Blyth, "The Estimation of Quinine in Wines and Tinctures, &c." and "The Figures or Patterns which drops of various Fats assume under certain conditions." 2. Mr. W. F. K. Stock, "A Modification of Wynter Blyth's Apparatus for digestions in Ether as applied to Milk Analysis," and "A New Burner for Griffin's Gas Muffle Furnace." 3. Mr. C. Heisch, "Some remarks on the Swedish Laws and the Quantity of Arsenic really Prohibited."

Tuesday, June 28th...National Health Society (at the House of the Society of Arts), 7½ p.m. Mr. S. Steven Hellyer, "The Science and Art of Sanitary Plumbing." (Lecture IV.) "House Drainage and Ventilation."

Statistical, Somerset-house-terrace, Strand, W.C., 4 p.m. Annual Meeting.

Anthropological Institute, 4, Grosvenor-gardens; S.W., 8½ p.m. Right Hon. Sir H. Bartle Frere, Bart., "The Laws Affecting the Relations between Civilised and Savage Life, as Bearing upon the Dealings of Colonists with Aborigines."

Royal Horticultural, South Kensington, S.W., 1 p.m.

Wednesday, June 29th...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting.

Thursday, June 30th...Victoria Institute (at the House of the Society of Arts), 8 p.m. Annual Meeting. Address by the Right Hon. the Lord O'Neill.

Society for the Encouragement of Fine Arts, 9, Conduit-street, W. Morning Meeting.

Friday, July 1st...National Health Society (at the House of the Society of Arts), 7½ p.m. Mr. S. Stevens Hellyer, "The Science and Art of Sanitary Plumbing." (Repetition of Lecture IV.)

Royal United Service Institution, Whitehall-yard, 3 p.m. Major J. C. Ardagh, "The Austrian Army."

Geologists' Association, University College, W.C., 8 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,493. Vol. XXIX.

FRIDAY, JULY 1, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

ANNUAL GENERAL MEETING.

The Annual General Meeting, for receiving the report from the Council, and the Treasurers' Statement of Receipts, Payment, and Expenditure during the past year, and also for the Election of Officers, was held, in accordance with the Byelaws, on Wednesday last, the 29th of June, at four p.m., F. J. Bramwell, F.R.S., Chairman of the Council, in the chair.

The Secretary read the notice convening the meeting, and the minutes of the previous annual general meeting.

The following candidates were proposed, balloted for, and duly elected members of the Society:—

Addison, Percy Leonard, 8, Arboretum-street, Derby, and Engineers' Office, Northern Division, Midland Railway, Derby.
Ainsworth, David, M.P., 25, Pont-street, S.W.
Armitage, William James, Farnley-house, Chelsea, S.W.
Bernard, Edmund Bowen, 51, Courtfield-gardens, South Kensington, S.W.
Blount, John, Maple Durham, Oxon.
Brearley, James Barnes, 77, Old-road, Middleton, near Manchester, and Jessamine-house, Barton-on-Irwell, Lancashire.
Brebner, Robert Charles, 10, Henry-street, Carlisle.
Britton, Percy Wilson, 14, Augusta-road, Ramsgate.
Brodie, George Bernard, M.D., 3, Chesterfield-street, Mayfair, W.
Brothers, Horatio, St. Lawrence, Putney-hill, S.W.
Courtney, C. F., City Surveyor's office, Manchester.
Crickmay, William, Caterham.
Day, Ernest, Worcester.
De Pape, William Alfred Harry, Coombs Croft-house, Tottenham.
Fernie, C. W.B., Keythorpe-hall, Leicester.
Freeman, Henry Somerson, 1, The Elms, St. Ann's-hill, Wandsworth-common, S.W.
Goodison, G. W., Esthwaite-lodge, Hawkshead, near Ambleside.
Grant, H. G., 24, Bull's Head Exchange-chambers, Market-place, Manchester.
Grimshaw, William, Stoneleigh, Sale, Cheshire.
Groth, Lorentz Albert, 97, Finsbury-pavement, E.C.
Giuliano, Carlo, 115, Piccadilly, W.
Harrison, Samuel, 11, Queen Victoria-street, E.C.
Hesketh, Everard, Dartford, Kent.
Hodding, Matthias Thomas, 77, Chancery-lane, W.C.
Johnson, Thomas Hilton, F.C.S., 36, Rawcliffe-road, Rice-lane, Walton, Liverpool.
Johnston, Thomas Ruddiman, F.R.G.S., 108, George-street, Edinburgh.
Jones, Charles, 35, Great Queen-street, Lincoln's-inn-fields, W.C.
Kennard, Stephen P., J.P., 17, Kensington-palace-gardens, W.
Lasseter, Frederic, 5, Porchester-gate, Hyde-park, W.
Lloyd, Alfred, B.A., Bush-lane, Cannon-street, E.C.
Nosotti, Charles, 395, Oxford-street, W.
Olsen, Ole Theodor, F.R.A.S., 40, Cleethorpe-road, Grimsby.
Owen, Lancaster, 38, Gloucester-gardens, W., and Engineers' Office, G.W.R., Paddington, W.
Paul, Joseph John Dawson, Eaton, Norwich.
Pfeil, A. L. A., Frognal, Hampstead, N.W.
Phillips, Alfred, 23, Cockspur-street, S.W.
Rutson, Albert, 7, Half-moon-street, Piccadilly, W.
Saunders, H. A. C., 11, Old Broad-street, E.C.
Stevenson, George Ernest, The Gas Works, Peterborough.
Thomas, Sidney Gilchrist, F.C.S., 27, Tedworth-square, Chelsea, S.W.
Tweddell, Ralph Hart, 14, Delahay-street, Westminster, S.W.
Tweedie, George R., F.C.S., 24, Josephine-avenue, Brixton-rise, S.W.
Walker, Philip F., 29, Prince's-gate, S.W.
Wickham, William Henry, 14, Essex-street, Strand, W.C., and Wimbledon hill, Surrey.
Williamson, William Blizzard, Providence Works, Worcester.
Young, Charles Edward Baring, 12, Hyde-park-terrace, W.

The Chairman nominated Dr. Mann and Capt. C. F. Gardner scrutineers, and declared the ballot open.

The Secretary then read the following—

REPORT OF THE COUNCIL.

The Council have now to lay before the members their report for the One Hundred and Twenty-seventh Session of the Society, and, in doing so, they are happy to be able to repeat the congratulations which their predecessors in office have now for some years past been justified in offering to the general body of members. The Society is, they are glad to think, flourishing in every way; its numbers are increasing, now for the first time for some few years, its finances are in a sound condition, its usefulness is as great as ever, and the Council are well assured its influence is as widespread and its reputation as high as at any period of its long and prosperous career.

I.—Ordinary Meetings.

Looking back through the list of papers read at the ordinary meetings of the past Session, it is satisfactory to be able to state that neither in popular interest nor in intrinsic value, do they compare unfavourably with those read in any former Session.

It has been the aim of the Council always to give the members the earliest possible opportunity of hearing, from the lips of the discoverers themselves, or of other competent persons, accounts of the various applications of science to purposes of daily life, of which our time is so productive. It is not now-a-days possible, or even desirable, for a Society to compete with the public newspapers as

an instrument of early intelligence. The public receive the first information of any scientific discovery from the daily Press, but they are also anxious for fuller information than can be supplied to them by such a channel; while, in many cases, they are glad of the opportunity of seeing the actual appliances by which the discoveries were made, or by which they are to be turned to practical account. It is, doubtless, this desire which draws to our room the large audiences which assemble there whenever any new advance in science, or any fresh application of science, is described. To chronicle such progress, to assist it, to make it known, these are the most important functions of our Society. If proof of this were wanting, the numbers attending our meetings alone would afford such proof, since whenever any new subject of scientific interest comes on for discussion, immediately the limited extent of our accommodation shows itself, and the difficulty of providing for our large numbers makes itself felt. Thanks to the many eminent men of science who have readily come forward to place their knowledge at the disposal of our members, there has been, during the Session now just finished, no lack of such papers.

Nor have the discussions, on the whole, been less satisfactory. With so many competing means of diffusing information, it can hardly be expected that the discussions at scientific societies should occupy the place they once did, and it is all the more satisfactory to see the high character of our discussions still kept up. Indeed, those of the past year show an advance on those of some previous years. It cannot but happen occasionally, that a discussion will fall into the hands of members not specially qualified to deal with the subject, whatever it may be, and when this is so, there comes a natural reluctance, on the part of those who really are so qualified, to take a share in it. The Council, however, think they are justified in stating that the discussions of this Session have, on the whole, been kept at rather a higher level than they have attained of late, for while there has been an equal readiness on the part of those who know to impart their knowledge, and to criticise; there has been, on the whole, less of that tendency which more or less characterises all public meetings—to talk more for the sake of talking than for any better reason.

After the opening meeting of the Session, at which Mr. Bramwell gave the usual address as Chairman of the Council, the first paper read was by Mr. Comyns Carr, on "The Influence of Barry upon English Art." This seemed a desirable opportunity, after their restoration, to draw special attention to the great masterpieces of Barry, which have now adorned the meeting-room for nearly a hundred years, and the subject was ably handled by Mr. Carr.

For the next meeting, fortunately, the aid of Professor Graham Bell, who happened to have come to England on a short visit, was secured. Professor Bell readily acceded to the invitation of the Council, that he should bring the Photophone, his latest and one of his most wonderful discoveries, before the Society, in the same manner as, four years ago, he had introduced his earlier invention, the Telephone. His paper was listened to by a crowded meeting, and the inadequacy of the accommodation possessed by the Society for the reading of papers of more than usual interest was again made evident, for it was unfortunately impossible to accommodate many members who wished to be present. The room, however, was filled to its utmost capacity by an appreciative and interested audience. The principles on which Mr. Bell had worked had been, a few days before, brought under the notice of the Royal Society, and the nature of his discoveries had of course been made public by means of the newspapers; still his paper read here was really the first introduction to an English audience of this latest and most marvellous development of Mr. Bell's inventive ingenuity.

The practical applications of electricity have also formed the subject for two other papers during the present Session, and the attendance at the reading of both these papers showed that the interest taken by the public in this important question is on the increase. In March, Mr. Preece gave an account of the recent advances in Electric Lighting, a paper which formed a very apt sequel to the series of Cantor lectures on the same subject, which were delivered by Professor Adams. The date for Mr. Preece's paper was arranged so that it followed immediately after these lectures, and by this means it was possible to use both for the paper and for the lectures a number of machines and lamps which were, by the liberality of the proprietors, placed at the disposal of the Society for the purposes of illustration. Messrs. Robey, of Lincoln, were good enough to lend an excellent steam-engine, for the purpose of driving the machines, and the Council were at some trouble and expense in arranging the various apparatus, so as to give the members as good an opportunity as space and time permitted of examining the latest means of producing the electric light. A more recent, but not less wonderful application of electricity, is to the transmission of motive power. An excellent paper on this subject was read at the last ordinary meeting but one of the Session, by Mr. Alexander Siemens. Mr. Siemens began by dealing with the theoretical principles involved, and gave the results of a long series of fresh experiments which have lately been carried out under the direction of Messrs. Siemens Bros. in Berlin. He then went on to describe the arrangements used for the electrical railway, illustrating his description by a working model of the apparatus. The paper gave rise to a very important discussion, which, indeed, had to be carried on to the following Wednesday evening, thereby concluding the business of the Session.

Dr. Alfred Carpenter's paper on "London Fogs," read at the beginning of December, was but too seasonable, and this, as well as the later paper read towards the end of January by Mr. Scott-Moncrieff, on a similar subject, attracted a considerable amount of public attention.

At the last meeting before Christmas, Mr. Price Edwards, the Secretary to the Deputy-Master of the Trinity House, read a very able paper on "Signalling by Means of Sound." The meeting at which this paper was read had the advantage of being presided over by Dr. Tyndall, and nearly all the principal authorities on this subject attended, and took part in the discussion. Mr. Edwards gave an interesting account of the measures which had been taken by the Trinity House for adding, by

means of sound signals, to the safety of our coasts. A cognate subject was dealt with in March by Sir William Thomson, who brought before the Society the system he has for some time been advocating, of enabling each lighthouse to identify itself to a passing ship by means of a special signal. This paper gave rise to a long and valuable discussion, which indeed may be said to have done something towards the clearing up of a difficult and complicated question.

After the Christmas recess, Professor Fleeming Jenkin introduced, to a London audience, a scheme for ensuring the proper sanitary condition of houses, which he has for some time successfully carried out at Edinburgh. Professor Fleeming Jenkin's paper led to the formation of an association similar to the Edinburgh Sanitary Protection Association, and the Council understand that this, as well as one or two others of a similar description, is progressing favourably.

Mr. Lock's paper on "Success and Failure in Modern Gold Mining" gave a good account of the processes usually adopted for the extraction of the metal from its ore; and also quoted the author's views on the alterations in system and process which were desirable. The great severity of the winter about this time was such as to render Mr. Lock's audience an extremely small one, and hardly more success was attained at an adjourned meeting for the discussion of the paper. The paper, however, aroused much interest, the subject being one which, as the members are aware, was then and is still attracting a great deal of attention. Mr. Stephen Bourne's paper on "Trade Prospects" was the first of several dealing with social and economical topics, rather than with scientific matters. It is found that many of our members are interested in papers of this character, and it is thought that considerable advantage results from the opportunity being given for the discussion of such subjects. Amongst this class may be enumerated Mr. Sedley Taylor's paper on "The Participation of Labour in the Profits of Enterprise;" Professor Bonamy Price's on "Buying and Selling;" and Mr. Edmund Johnson's paper upon the "Trade Marks Registration Acts." The first and principal Act has now been at work for five years, and the period during which it is possible to register an existing trade mark has therefore expired. This fact gave a good opportunity for Mr. Johnson to sum up the results of the working of the Act, and to point out various improvements which, in his opinion, and in that of other authorities, seem to be desirable. There was also a paper upon "Explosions," by Mr. Cornelius Walford, who gave the results of careful research into the statistics of the subject for a long time back.

The applications of Art to industry have always formed one of the most important departments of the Society's work. Nor has it been neglected in the selection of papers for reading at the ordinary meetings. Under this head are to be classed Mr. Hungerford Pollen's paper on "The Art of Wood Carving," read in February; Professor Church's on "The Artistic Use of Precious Stones," read a little later in the Session; and, near the end of the Session, the paper by Mr. H. J. Powell, of the Whitefriars Glass Works, on "The Manufacture of Glass for Decorative Purposes."

The papers yet remaining to be noticed include one on "River Conservancy," by Mr. Cresswell, a subject of which he has treated before in the Society's Room, and one which has for some years attracted special notice from the Society. Next came a paper by Mr. Edward Whymper, giving an account of the writer's ascents of Chimborazo and Cotopaxi last year. In this case, as in that of Professor Bell, it was found absolutely necessary to restrict the admissions, but in order to give the greatest possible number of members the opportunity of hearing Mr. Whymper, the loan of the lecture theatre at South Kensington was obtained for the evening, through the kind permission of the Lords of the Committee of Council on Education.

II.—Indian Section.

The Indian Section has had a most successful Session this year, all the papers being of a high character, and some of them extremely important. The work of the Section began with a communication from Sir Richard Temple, on "Forest Conservancy in India." This is a subject with which Sir Richard Temple has been closely connected, and the paper which he read upon it was both interesting and important. Had it not been that the meeting took place during the week of the severe snow-storm, which, for a time, almost suspended traffic in London, the audience would, doubtless, have been larger than it was, but, even under these unfavourable circumstances, the reading of the paper was well attended. Mr. Hyde Clarke's paper on the "Indian Gold Fields," read at the next meeting of the Section, formed a valuable and indeed a necessary supplement to the paper previously read by Mr. A. G. Lock, on a similar subject, at one of the ordinary meetings of the Society. Mr. Lock, of course, had dealt with the question of gold mining generally, while Mr. Hyde Clark treated the special subject of the "Gold Fields of India." The third paper was an admirable exposition of "The Results of British Rule in India," by Mr. J. M. Maclean, who is recognised as an eminent authority on the subject. Sir George Campbell followed with a subject with which his name has long been connected —"The Tenure and Cultivation of Land in India." The fifth paper was by General Maclagan on the "Building Arts of India," while the sixth and concluding one was by General Sir Arthur Phayre, on "British Burma." This paper is really a model of complete information in a concise form. It has been suggested at different times that it would be useful if a selection were made from the papers which have been read at the various meetings of the Indian Section since its formation, with a view to its separate publication. The Council do not feel themselves able at present to offer any opinion on this matter, but they propose to take it into further consideration.

III.—Foreign and Colonial Section.

In the Foreign and Colonial Section the business of the Session commenced by a paper on "The Industrial Resources of South Africa," by Sir Bartle Frere, G.C.B., who opened the section seven years ago with an inaugural address. This paper was notable for the large amount of valuable information supplied regarding the

progress and prospects of a district to which recent events have so strongly drawn public attention. Mr. Cust also contributed an interesting sketch of the classification and structural relations of the languages of Africa, in the discussion of which Dr. Koelle, the distinguished philologist, took a prominent part. An account of the present state of the diamond fields of South Africa, and the progress of their operations, was communicated by Mr. R. W. Murray, who had been connected for ten years with the district. Mr. Hepple Hall's memoir of the colony and dominion of Canada was most suggestive and practical, containing as it did an admirable historical sketch of the commercial progress of this important dependency. Mr. Westgarth's remarks on the trade relations that connect her colonies with Great Britain, excited a considerable amount of attention, and led to a lively discussion. The immediate interest of Mr. Gubbins' paper upon Loo Choo, and its curious two-fold connection with the Empires of China and Japan, was materially increased by the presidency of Sir Harry Parkes, K.C.B., her Majesty's Minister at the Court of Japan, and by his promise of a future contribution to the Section concerning the commerce of the country with which he is officially connected.

IV.—Section of Applied Chemistry and Physics.

Five papers were read in this Section; a sixth had been set down upon the list, but the sudden and severe indisposition of the author of it, Mr. Shelford Bidwell, prevented its being read. In the first paper, Mr. James Mactear gave an account of his system of manufacturing sulphate of soda. It will be in the recollection of the members that, three years ago, Mr. Mactear described to the Society the furnace known by his name, at a meeting of the Chemical Section, in a paper for which the Council awarded a medal at that time. In his second paper, Mr. Mactear described the various improvements which he has since made in his furnace, with the object of rendering its action continuous. The second paper read in the Section was by Mr. J. Y. Buchanan. Mr. Buchanan is well known as having occupied the position of chemist to the *Challenger* expedition, and the experience he then gained enabled him to write a very valuable paper upon "Deep Sea Investigation, and the Apparatus Used in it." The paper may be said to be fairly exhaustive of its subject, and, it may be hoped, will take rank as a monograph upon it. This was followed by a paper by Professor Perry, on "The Future Development of Electrical Appliances." The subject of Professor Perry's paper may be said to be the application of electricity to purposes other than illumination. The same remark applies to it as has been applied to papers on electrical subjects read before the ordinary meetings of the Society—that it attracted much attention from the members, and brought together large audiences. Mr. Stillingfleet Johnson dealt with a subject which has frequently of late been before the Society in his paper on the effects of impure water upon health; while Professor Huntington concluded the business of this Section by an able *resumé* of recent progress in the manufacture and application of steel.

V.—Cantor Lectures.

It has been the practice of recent years to arrange for three sets of Cantor lectures in each Session, each set consisting of some five or six lectures. It is hardly necessary to say that most of the subjects with which the Cantor lectures deal are such that it would be difficult to deal with them completely, even in much longer courses; but, on the other hand, it is often inconvenient for members to make arrangements to attend week by week, courses extending over a period of six weeks. For the Session just passed, therefore, arrangements were made for a greater number of courses, while the courses themselves were made up of a smaller number of lectures. There were accordingly five series of Cantor lectures. Of these, the first was delivered by Professor Church, his subject being "The Scientific and Artistic Aspects of Pottery and Porcelain." These lectures were given during the early part of the Session, previous to Christmas, and were well attended. The first course after Christmas was by Mr. Edward Rigg, the subject being "Watchmaking." This course also attracted good audiences; and, as on former occasions, when the subject of a course of lectures was connected with any London trade, a limited number of admissions were given to watchmakers and their apprentices, many of whom availed themselves of the opportunity of adding to their knowledge of the theory of their business. Mr. Rigg's lectures were specially valuable from the want of technical literature in this country on the subject of watchmaking; and this fact will add to their value when they make, as they shortly will, their appearance in the *Journal*. The largest audiences at the Cantor lectures of the Session, however, were those which attended the third course on "The Scientific Principles Involved in Electric Lighting" by Professor Adams. For these the room was crowded to its utmost capacity. Prof. Adams, lectures were amply illustrated by a fine collection of apparatus, and also by examples of several of the principal systems of electric lighting. Of the arc systems, the Brockie lamp, Siemens lamp, and Serrin lamp were shown at work, other lamps and "candles" being exhibited, but not lighted. Great interest also attached to the exhibition by Mr. Swan of his new incandescent light. The next course was by Mr. Alan S. Cole, upon the "Art of Lace-making." These lectures were well illustrated by some valuable specimens of lace, lent for the purpose, and also by a fine collection of transparencies, representing the various descriptions of lace, which were shown on the screen by the aid of a lantern. The Cantor lectures of the Session were concluded by an important course on "Colour Blindness," delivered by Mr. R. Brudenell Carter. Mr. Carter drew special attention to the effect of colour blindness upon various industries, and brought before his audience the tests which have recently been devised for the detection of this curious defect. The Council think it right to say that Mr. Carter, being a member of Council, could not accept the usual fee for his lectures.

VI.—Juvenile Lectures.

In these lectures, the Council have always endeavoured to consider rather what would be interesting and instructive to the youthful audi-

ence than to strictly confine the range of the lectures to subjects properly coming within the scope of the Society. They, therefore, invited Mr. G. J. Romanes, the well-known naturalist, to give the usual short course of lectures at Christmas, upon a subject which he has made his own, the intelligence and instinct of animals. The lectures were very well attended, and appeared to afford great satisfaction to the audience that listened to them.

VII.—ALBERT MEDAL.

The Council feel convinced that the award of the Albert Medal, this year, to Dr. A. W. Hofmann, F.R.S., "for the eminent services rendered to the industrial arts by his investigations in organic chemistry, and for his successful labours in promoting the cultivation of chemical education and research in England," will give universal satisfaction. For the past forty years, Dr. Hofmann, one of Liebig's earliest and most distinguished pupils, has laboured with an indefatigable zeal, equalled only by the success of those labours, in the development of some of the most important branches of organic chemistry. While the very high scientific value of Dr. Hofmann's researches has been, from time to time, recognised in this country by the award to him of the Royal and Copley Medals of the Royal Society, and of the Faraday Medal of the Chemical Society, the fact that some of his most remarkable researches laid the foundation of the coal-tar colour industry, while others furnished important contributions to its rapid development, is now fitly recognised by the award of the Albert Medal of the Society of Arts.

There are, however, other quite separate and certainly not less prominent claims to this distinction which the Society of Arts desire to recognise in awarding the medal to Dr. Hofmann. When the College of Chemisty was established, in 1845, with H.R.H. the late Prince Consort as its ardent patron, and Dr. Hofmann as its first Professor, the facilities for the acquisition of chemical knowledge by students in this country were of a very limited nature, and within the reach of but few; and the training requisite for the pursuit of chemistry as a science or profession, and for its application to Manufactures and the Arts, had to be sought in Germany and France. It is due to the indefatigable exertions and perseverance of Dr. Hofmann, in the face of most formidable difficulties—to his remarkable powers as a teacher and lecturer, and to the faculty, peculiarly his own, of inoculating his pupils with his enthusiastic love of chemical research, that the Royal College of Chemistry speedily became developed into a world-renowned school of chemical science; while its success imparted a great impetus to the cultivation of that science, and of its application to the Arts and Manufactures of the United Kingdom. Among those English chemists who have, in later years, conspicuously contributed to the development of chemical industries and to the advancement of chemical knowledge, some of the most prominent are proud to claim as their master the eminent man upon whom the Society of Arts now confers its highest distinction.

VIII.—MEDALS.

According to the usual custom, the Council have awarded Silver Medals for certain of the papers read during the Session before the Society, at the ordinary meetings and in the different Sections. For the present year, eight medals have been awarded; of these, three were given for papers read at the ordinary meetings, two for papers in the Indian Section, one for a paper in the African Section, and two for papers in the Chemical and Physical Section. The Council also passed a vote of thanks to one of their own members, Mr. Preece, for the very interesting paper which he read, upon "Recent Advances in Electric Lighting." The following is a complete list of the awards:—

To Professor ALEXANDER GRAHAM BELL, for his paper on "The Photophone."

To E. PRICE EDWARDS, for his paper on "Signalling by Means of Sound."

To ALEXANDER SIEMENS, for his paper on "The Electrical Railway, and the Transmission of Power by Electricity."

To Sir RICHARD TEMPLE, Bart., G.C.S.I., C.I.E., D.C.L., for his paper on "Forest Conservancy in India."

To J. M. MACLEAN, for his paper on the "Results of British Rule in India."

To Sir HENRY BARTLE EDWARD FRERE, Bart., G.C.B., G.C.S.I., D.C.L., LL.D., for his paper on "The Industrial Products of South Africa."

To J. Y. BUCHANAN, F.R.S.E., F.C.S., for his paper on "Deep Sea Investigation, and the Apparatus used in it."

To Professor JOHN PERRY, for his paper on "The Future Development of Electrical Appliances."

IX.—EXAMINATIONS.

Those who have interested themselves in this department of the Society's work, are aware that considerable changes were made in the examinations, after due announcement, a year ago, many of the subjects in which examinations had been held being struck off the list. The reasons which induced the Council to take this step have been fully stated in the *Journal*, and in previous annual reports. The past year was the first under which the new system came into practice. According to the plan adopted, only those subjects were retained in which it did not appear that any other examination was provided for students, the subjects retained being Clothing, Cooking, Health, Housekeeping, Political Economy, and Music. In all these subjects, except in Music, there has been a serious falling off, the numbers of candidates for the present and for last year being as follows:—

	1880.	1881.
Clothing	84	3
Cookery	118	95
Health	114	42
Housekeeping	50	14
Political Economy	40	27
Music	324	321

The cause of this diminution is doubtless to be found in the fact that the abandonment of the greater number of subjects has reacted on those retained, for many candidates who took up some of the latter as supplementary, do not now enter at all. In former examinations a separate day was given for each of the Domestic Economy subjects; there is now only one day for the whole number.

The Council are much indebted to the Science

and Art Department for the assistance which they have rendered, in permitting candidates for the Society of Arts Examinations to be examined in connection with the candidates at the Government Examinations.

X.—Prince Consort's Prize.

The Prince Consort's Prize of Twenty-five Guineas, originally offered by his Royal Highness the late President of the Society, and graciously continued by her Majesty the Queen, was offered annually to the candidate who, obtained under certain conditions, and within a space of four years, the greatest number of First-classes in the subjects for examination. The altered scope of the examinations rendered it necessary for the Council to ascertain her Majesty's wishes in respect of the prize, and she gave it as her opinion, that as the system of education, which the Prince Consort had desired to encourage, was now to a large extent carried on by the Science and Art Department, the time had arrived when the award of the prize might well be discontinued. No offer of the prize was therefore made for the past year.

XI.—Examinations in Practical Music.

In consequence of the success of these examinations, which were held for the first time in 1879, it was thought desirable that there should be two examinations in London during the year, instead of only one, and it was determined that they should take place in January and in July. For the January examination, 75 candidates entered, 72 presenting themselves for examination, some of whom were examined in singing as well as in playing. 42 certificates of the first-class were awarded, and 33 of the second. 59 of these candidates were students of the pianoforte, 4 of the organ, and 2 of the violin; and there were 23 vocalists. 4 candidates entered for honours, of whom 2 took first-class certificates and 1 a second-class. It is worth noticing that 2 of the candidates for the general examination were awarded full marks by the examiners. Dr. Hullah, the Society's examiner, expresses in his report a very favourable opinion upon the results of these practical examinations as a continuation of the theoretical examinations in the theory of music started by the Society of Arts in 1859. Dr. Hullah also remarks that in the period of twenty years during which these examinations have been held, there has been "an amount of progress in execution, style, ear, reading, and general musical culture, no parallel to which, in the same space of time, has been presented in any other age or country." A practical examination in music has also been held at Glasgow under the supervision of the Society.

The second examination for the current year will be held at the Society's House during the week commencing Monday, the 4th July. For this a larger number of candidates have entered than at any previous examination.

XII.—Musical Education Committee.

This committee, which was appointed the year before last, and whose first report was referred to in the last annual report of the Council, have been continuing their labours. They have issued two short reports dealing with the system under which music is now taught in elementary schools, and also with the proposals at present under consideration for the establishment of a college of music in connection with the Training School for Music at South Kensington. The first of these reports, being the second report actually published by the committee, has appeared in the *Society of Arts Journal*. The committee's third report can be obtained by purchase at the Society's office.

XIII.—National Training School for Music.

In November last, a statement was issued by H.R.H. the Duke of Edinburgh, as President of the Committee of Management of the school, reminding the founders of scholarships that the period of five years, for which the school was originally established, would expire at Easter, 1881. This statement held out the hope that a permanent school of music, under the management and control of the State (as originally designed by the Society of Arts), might, at no remote period, be established; but it also stated that the negociations which the committee of management of the school were carrying on, were still in progress, and that however favourably they might terminate, it would not be possible to inaugurate such a new institution by Easter last. The committee, therefore, appealed to the founders that they should renew the scholarships for one year, from Easter 1881 to Easter 1882. The application was addressed to the Society as having founded four scholarships at the school. The matter was fully considered by the Council, and eventually it was determined that a sum of £160, the equivalent of the annual amount granted by the Society for the establishment of its four scholarships, should be placed at the disposal of the National Training School for Music towards the maintenance of the school. In making this grant, the Council left it to the committee of the school to decide in what manner the money should be employed—whether in founding fresh scholarships, continuing old ones, or in any other way which might seem desirable to the committee.

The two scholarships provided by subscriptions from members of the Society and others have been renewed for one year, one of the subscribers, Mr. W. Atkinson, having very liberally increased the amount he formerly gave, in order to ensure that the full sum of £80 should be forthcoming.

The grant of £160 made by the Society, as above stated, has been used by the committee of management of the school to endow four scholarships, which have been awarded as follows:—Eugénie Bênard, pianist; F. W. Crooke, violinist; Helen Synyer, pianist; and Florence M. Warman, pianist.

The two scholarships subscribed for by members and others have been awarded to Monimia Twist, pianist, and Alice Menzies, pianist.

The actual result of the appeal of the committee was the endowment of 82 scholarships for a year; and the committee have also received donations, for general purposes, amounting to £110 10s., besides the £160 grant from the Society, which the committee have disposed of, as above-mentioned, in founding scholarships. Dr. Sullivan having retired from the Principalship, Dr. Stainer, the late Vice-Principal, has been appointed Principal, and Dr. Sullivan has been placed on the Committee of Management of the school.

The school has been recently examined by a body of examiners appointed by H.R.H. the Prince of Wales, and consisting of Sir Michael Costa, Sir Julius Benedict, Sir George Elvey, Dr. John Hullah, Otto Goldschmidt, Esq., W. S. Cusins, Esq., and Henry Leslie, Esq. The report of these gentlemen, after dealing fully with details, concludes as follows:—(The examiners) "consider that the school has done and is doing much good work. It would be a national misfortune if it did not continue its operations. The examiners hope that those occupying the leading position in its direction will spare no efforts to secure that great *desideratum*, a Musical and Dramatic Conservatorium, which shall be the central home for all that is most talented and artistic in Great Britain and its dependencies."

It is satisfactory to be able to state, that twenty-eight of the scholars left the school last Easter, to enter upon the active duties of the profession for which they had been preparing themselves at the school. Most of these, it is reported, have obtained good positions, some as public singers or players, some as organists and choirmasters, and some as teachers.

XIV.—PATENT-LAW.

In the address delivered by Mr. Bramwell, as Chairman of the Council, at the opening of the Session, special attention was drawn to the subject of the improvement of the Patent-law. The Council have had under consideration the best steps the Society of Arts could take in order to bring about the much-needed improvements in the law, and they came to the conclusion that the most useful plan to pursue would be to draft a Bill, which should be, so far as the powers of those engaged upon it could make it, a perfect measure, whether or not it might be possible eventually to pass all its provisions into law. The Council appointed a committee to prepare this Bill. The Committee has met frequently and has given much thought and attention to the subject. The Council would have been glad if it had been possible to have presented their draft Bill to the members before the conclusion of the Session; but the work, as might be expected, proved too great for this to be done, and, though a draftsman is now engaged upon the Bill, under the instructions of the committee, it has not been found possible to get it so far advanced as to submit it before the present time. So soon as the work of the committee and the Council is fairly complete, the Council propose to bring their Bill before a meeting of the Society, specially summoned to consider it. After it has been fully discussed by such a meeting, it will then be reconsidered by the Council and their committee, and measures will be taken to get it introduced into the House of Commons for the next Parliamentary Session. The Council think it wiser to defer, until they can bring the whole matter forward in a complete shape, any statement as to the principal provisions which are being introduced into the Bill; they can only say that the committee has given careful attention to all the suggestions which have been made by various bodies for the improvement of the law, and that they hope to produce a measure which will, so far as it is possible, give satisfaction to those competent to form an opinion upon it. The Council consider this to be one of the most important pieces of work which they have undertaken for some time, and they think that if, before the next Session of Parliament begins, they can bring forward a thoroughly good and practical measure for the reform of the Patent-laws, that the year in which this has been effected will not have been a barren one, so far as the Council's labours are concerned.

XV.—ART FURNITURE EXHIBITION.

It may be remembered, that some years ago, a series of Art-Workmanship Exhibitions was held by the Society of Arts. The movement commenced in 1862, towards the end of which year an application was made by the Society of Wood-carvers, asking the Society of Arts to assist them in holding an Exhibition of Wood-carving. The application was agreed to; the Society of Arts made a grant of £30 and a silver medal, the Wood-carvers' Society promising £15. The Exhibition was held in the latter part of the Session of 1863, and prizes were awarded in three classes for wood-carving. In the following year, it was determined to extend the scope of the Exhibition, and prizes were offered to workmen in ten different classes. For the competition seventy works were submitted, and prizes were awarded in nearly all the classes. For the following year — 1864 — the Council offered prizes amounting to upwards of £500. The works were arranged in two divisions—1. Works to be executed from prescribed designs; and, 2. Works to be executed without prescribed designs. In the first division there were 18 classes. The second division comprised three classes of wood-carving. In response to this offer, 87 works were sent in, and prizes to the extent of £274 were awarded among 37 competitors. The Exhibition of these works was held at Christmas, 1864. Previous to holding the next year's competition, a meeting of workmen was held, the scale was extended, and the amount of prizes increased to £600. As before, the works were arranged in two divisions, according as they were executed from designs or without designs. The classes in the first division were identical with those of the previous year, a class being added, however, for illuminations. The competition in 1866 does not seem to have differed materially from those of former years. From this year, up to 1871, the competitions were continued in much the same manner; but when the first of the series of Annual International Exhibitions was held, it was considered that they would, to some extent, occupy the place of the Exhibitions of Art-Workmanship, and, therefore, the movement was brought to an end.

Last autumn a proposal was submitted that these Exhibitions should be revived, and that medals and certificates should be offered to workmen who had designed or shared in the construction of objects of art-workmanship. The proposal was approved, and a committee was appointed to carry it into effect. The Council of the Royal Albert Hall undertook to provide space, and to assist in other ways. On further consideration, it appeared desirable that the Exhibition should be restricted to furniture alone, instead of embracing all kinds of Art-manufactures, as was the case with those formerly held, and, accordingly, arrangements were made with the following firms, by which

each firm undertook to fill a certain share of the available space:—J. G. Crace and Son; Morant, Boyd, and Blanford; Jackson and Graham; Gillow and Co.; Holland and Sons; Howard and Sons; Wright and Mansfield; Collinson and Lock; Gregory and Co.; Shoolbred and Co.; Johnstone, Jeanes, and Co. All these firms readily accepted the regulation that the prizes should be awarded not to the actual exhibitors, but to the workmen; and they undertook to assist the judges in making their awards. It was also understood that these firms would afford facilities to exhibitors of articles which might be considered as accessories of furniture, such articles being shown in company with the specimens of art furniture exhibited. Besides these, several other manufacturers of furniture, and of accessories of furniture, are showing specimens of their productions.

Without any exception, the firms above mentioned took up the matter most cordially, and the result is a most interesting and attractive collection of high-class modern furniture. All who have visited the Exhibition, speak of it in warm terms of commendation, and the Council hope that it may be the forerunner of others of equal interest in future years. Members of the Society have the right of free admission by ticket. The exhibition will remain open till the end of July, or till some time in August.

The award of medals and certificates to the workmen employed in the manufacture of the exhibits has not yet been made, but a committee has been appointed, and they have now the matter in hand.

XVI.—Memorial Tablets.

During the past Session tablets have been erected on six houses to mark the residences of the following celebrated men :—

James Barry—36, Castle-street, Oxford-street.
William Hogarth—30, Leicester-square.
[This house has been rebuilt for Archbishop Tenison's School.]
Sir Isaac Newton—35, St. Martin's-street.
Peter the Great—15, Buckingham-street, Strand.
Richard Brinsley Sheridan—14, Savile-row.
Sir Robert Walpole—5, Arlington-street.

In former years the Society of Arts has placed these memorial tablets on houses inhabited by Burke, Byron, Canning, Dryden, Faraday, Flaxman, Franklin, Garrick, Handel, Johnson, Napoleon III., Nelson, Reynolds, and Mrs. Siddons.

The Council have under consideration a list of houses on which such tablets might properly be put, and they would be glad to receive any information or suggestions which might assist them in selecting other suitable buildings.

XVII.—Arsenical Colours.

The committee, whose appointment was mentioned in last year's report, have, during the past Session, appointed a sub-committee, which carried on a careful series of investigations in order to lay down precise, and, if possible, simple instructions for testing the existence of a harmful amount of arsenic in coloured fabrics and paper. The sub-committee have prepared instructions, and have reported through the General Commtitee to the Council. The report has only just been received, and in a matter of so much importance as this is, it has been thought better not to publish it until it has received the full consideration it deserves on the part of the Council. The Council feel that the thanks of the Society are due to the members of the whole committee, who have paid constant attention to the matter, and more especially to the members of the sub-committee, Mr. Heisch and Dr. Bartlett, who carried on the investigations, and gave to them a great deal of their valuable time.

XVIII.—Barry's Pictures.

The well-known pictures by Barry, in the Society's Great Room, being in a very dirty condition, it was determined last year that they should be cleaned. They underwent the process successfully during the summer recess, and their appearance was much improved by it. These pictures have now been in the Society's possession for nearly one hundred years, the first public exhibition of them having been made in 1783. As appears from the Society's records, they have been cleaned three times previous to the cleaning they received last year, namely, about 1834, in 1846, and in 1863. The cleaning which they underwent last year was as slight as possible, the pictures having only been washed over, and nothing having been done which would in the least degree affect their surface. The work was skilfully performed by Mr. Andrew, of the South Kensington Museum. Forming, as these paintings do, almost the solitary monument of the genius of a very remarkable artist, they deserve the greatest care that could be bestowed upon them, and it is satisfactory to be able to report that they are in good condition, and likely to remain so for many years to come. At the same time as the pictures were cleaned, the decorations of the Room were cleaned, and the walls painted.

XIX.—Inland Telegrams.

It was stated in the last annual report that the Council had addressed a memorial to the Postmaster-General, asking him to reduce the tariff for inland telegrams. In July last a deputation from the Council waited on Mr. Fawcett, and had the advantage of hearing from him a very important statement as to the views of himself and the Government upon the question of reducing the tariff. It appeared, from what Mr. Fawcett said, that in the opinion of the department there could be little doubt that a reduction in the tariff would involve, at all events, a temporary reduction in the revenue, and the deputation gathered that as soon as the Chancellor of the Exchequer was in a position to face such a reduction in the revenue, there was a reasonable hope that the charges for inland telegrams would be lowered. A full report of Mr. Fawcett's speech, as well as of the observations made by Mr. Edwin Chadwick and by other members of the deputation, appeared in the *Journal* for July 23rd, 1880.

XX.—Sydney International Exhibition.

The Commissioners for the Sydney International Exhibition have been good enough to present to the Society of Arts a gold medal and a diploma, in recognition of the assistance rendered

to the Exhibition by the loan of Barry's painting, "The Temptation of Adam," and also in recognition of the gift of engravings and etchings by Barry, which the Society presented to the Art Gallery of New South Wales, after they had been exhibited at the Sydney Exhibition.

XXI.—OWEN JONES PRIZES.

These prizes are awarded on the results of the annual competition of the Science and Art Department, to students of Schools of Art, for designs for furniture, carpets, &c., on the principles laid down by Owen Jones.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design," and a Bronze Medal.

The successful candidates were—J. W. Riley, School of Art, Halifax; G. Potter, School of Art, Derby; Fanny Buckfield, School of Art, Northampton; Lucie Shepherd, School of Art, Northampton; James Henderson, School of Art, Dundee; Thomas Smith, School of Art, Coalbrookdale.

XXII.—PLANT LABEL.

At the end of last year, Mr. G. F. Wilson, F.R.S., requested the Council of the Society to undertake the award of a prize of £5, which he placed at their disposal, for the best label for plants. The object of the offer was to obtain a cheap and durable label, and thus to supply a want much felt by horticulturists. The Council accepted the duty, and added to Mr. Wilson's offer, a Society's silver medal. In answer to an announcement made to this effect, 120 sets of labels were sent in by the appointed day, namely, the 1st of May last. These are now under the consideration of a committee, which it is expected will soon be able to report as to their merits.

XXIII.—HOUSE SANITATION.

In January last, the Council published an offer of three Silver Medals, for the best sanitary arrangements in houses within the metropolitan area. The medals were offered to the occupiers, lessees, or owners of the houses. One medal was to be awarded for a house let out in tenements to artisans, for which a weekly rental is paid; one for a house of a yearly rental of from £40 or less to £200; and one for a house of the yearly rental of £200 and upwards. In answer to the offer, six owners submitted their houses in competition, and the award of the prizes is now under the consideration of a committee of judges appointed by the Council.

XXIV.—SANITARY ARRANGEMENTS OF SOCIETY'S HOUSE.

It was thought desirable to examine into the condition of the drains of the house, and the examination revealed so defective a state of things that it was determined to amend the system. This was done by Mr. E. Griffiths, under the supervision of Mr. Robert Rawlinson, C.B., on the most approved principles, and at an expense, on the whole, of £338, this sum also covering the cost of a new lavatory, which has been arranged for the convenience of members. A room on the ground floor, next the library, has been devoted to this purpose. Messrs. Doulton were good enough to present the Society with all the necessary fittings.

XXV.—DOMESTIC ECONOMY.

A Congress for the purpose of promoting the teaching of Domestic Economy in Elementary Schools has been held in connection with the Society. An Executive Committee was appointed by the Council, and by their assistance an influential committee of ladies was formed, under the presidency of H.R.H. Princess Christian. This committee divided itself into sub-committees, each sub-committee dealing with one of the divisions of the subject according to the classification adopted by the Education Department.

The Congress was opened on the 20th June, by a *Conversazione* in the Royal Albert Hall, which was largely attended. The meetings for the reading and discussion of papers were held in the Rooms of the Society and in the Albert Hall, on the following days of the week. The subjects discussed included "Methods of Teaching and Examining Domestic Economy," "Needlework," "Food and Cookery," "The Dwelling," "Health," and "Thrift." As many as 56 papers were contributed under these different heads.

The following report of the Executive Committee has been received by the Council:—

1. The Executive Committee, at the last meeting of th Congress, presided over by the Countess of Derby, have the pleasure of reporting to the Council of the Society of Arts that the hopes of success entertained when the Council sanctioned the holding of a Congress of Domestic Economy in London have been fully realised.

2. The Congress was opened at the Royal Albert Hall on Monday evening, 20th June, and attracted a company numbering more than five thousand persons, the majority of whom were members of the Society. The opening was made interesting by the lighting up of the Conservatory of the Royal Horticultural Society by several systems of electricity; by the agreeable singing of children trained on the Tonic Sol-fa method; by the effective singing of the students of St. Mark's College, Chelsea; of the vocal and instrumental performances of the students of the National Training School of Music; by the playing of the bands of the Military Asylum, Chelsea, and of the Coldstream Guards.

3. The reading of papers and discussions during the Congress have been able and practical, and have been carried on daily during the week, under the presidencies of the Countess of Airlie, the Duchess of Leeds, the Countess Spencer, the Viscountess Strangford, the Dowager Lady Stanley of Alderley, Lady Reay, and Mrs. Dacre Craven, ladies most experienced and accomplished for the purpose.

4. Her Royal Highness the Princess Christian of Schleswig Holstein presided at the delivery of Mrs. Buckton's lecture, and cordially expressed the knowledge and gratification she had derived from hearing it.

5. The success of this Congress is entirely due to the great and sympathetic interest which women, rather than men, have taken in it. Very few important female minds, thoughtful on women's home duties, and knowing how to teach them, have been absent.

6. The success shadows the likelihood of that forthcoming change in the Education Code, which the Congress has advocated; and confidence may be expressed that public opinion will support the Education Department in realising such necessary change.

7. Reports of the papers and discussions have been published daily, and they will be collected together hereafter. The Executive Committee recommend that some very able papers having much scientific interest, but not especially appropriate to the teaching of Domestic Economy in Elementary Schools, should be published in Society's *Journal*.

8. Before the conclusion of the Congress, strong convictions were expressed by the members unanimously, that this

Congress was only the beginning of a movement for connecting the knowledge of home duties with the earliest teaching of children by women, and securing that reform of the Education Code which has been announced by the Lord President and Vice-President of the Lords of the Committee of Council on Education.

9. Accordingly, a very satisfactory beginning has been made to collect funds for preventing interruption to the work of the Congress, and for holding another Congress in 1882, when it is hoped that the plan of a National Institution, with local branches throughout the United Kingdom, may be matured and submitted to the Congress for approval. The Executive Committee have the great satisfaction of reporting that her Royal Highness the Princess Christian has expressed her gladness at continuing at the head of this movement, which is of the very highest national importance to all subjects of the Queen.

XXVI.—Education Committee.

In May last, on the motion of Mr. Edwin Chadwick, the Council appointed a committee to consider the question of the Education Code, and to suggest any measures of reform which, in their opinion, it might be desirable to bring under the notice of the Education Department. The committee has met once, but it has not yet reported to the Council. It is now some time since the Council have appointed an Education Committee, but reference to the back numbers of the *Journal* will show that, some years ago, when such a committee existed, it was the means of bringing before the Society much useful information on national education and kindred subjects.

XXVII.—Food Committee.

It will be in the knowledge of the members that there has long been a standing committee of the Council for the purpose of treating matters relating to the food supply of the country. The committee was formed in 1867, and for some years after its formation published the results of a number of elaborate inquiries and examinations made by its members. The committee also took a large amount of evidence on the subject of food supplies and distribution, which also was published in the Society's *Journal*. The committee have also had at their disposal now for many years a prize of £100, presented to the Society by the late Sir Walter Trevelyan, for the best method of preserving fresh meat. Though numerous methods, more or less successful, for treating meat have been before the committee, the committee have never felt themselves able to select any one as being so far superior to the rest as to deserve the award of the prize, neither have they had from any of those persons who are now engaged in the importation of meat preserved by means of cold from America or Australia any such precise claim to the credit of the invention as would warrant the committee in thus awarding the prize. The prize, therefore, still remains in the charge of the Society, and the Council would gladly welcome the advent of any process which would justify them in presenting it.

With a view of further considering this important subject, the Council have recently re-organised and enlarged the Food Committee. They have secured the assistance of a large number of gentlemen specially conversant with the subject, who will act as a General Committee, and this committee has divided itself into seven sub-committees, which will deal with the following divisions of the subject:—

1. Fresh Animal and Vegetable Products, Home and Foreign.
2. Preserved Animal and Vegetable Products, Home and Foreign.
3. Fish—fresh or preserved.
4. Drinks of all kinds.
5. Cookery.
6. Scientific questions affecting the composition, adulteration, preparation, methods of preservation, nutritive and dietetic value, &c., of various kinds of food.
7. Matters affecting importation, customs and excise, revenue rates, &c., of food.

It is proposed to hold a general meeting every year, at which the actual condition of the question may be considered, and the Council are glad to be able to announce that Professor Huxley has undertaken to preside at the meeting in 1882, and, in the meantime, to act as chairman of the committee. The sub-committees will, it is hoped, be able at this meeting each to bring up a report on its own division of the subject, and the Council trust that by thus calling public attention to the matter, they may be doing useful work in a direction in which the Society has, since its foundation, so frequently laboured.

XXVIII.—Copyright.

The Society for the Amendment of the Law have had for some time in hand a Bill for the improvement of the law of copyright. Having drafted the Bill, they applied to various institutions for assistance in providing a fund to cover the necessary expenses. Inasmuch as Art-copyright is a subject with which this Society has long been associated, the existing Act on that subject having been passed through the agency of the Society of Arts, the Council felt themselves justified in contributing ten guineas to the fund.

XXIX.—Obituary.

During the past year many notable names have been removed from the Society's list of members. Obituary notices of all the following have appeared in the pages of the *Journal*, so it must suffice here merely to recapitulate the fact of their loss.

The first on our obituary list for the present Session was the Rev. Arthur Rigg. Few members of the Society took a more active interest in its welfare than Mr. Rigg, and few were more ready to render it assistance. He gave the Society three courses of Cantor lectures, and also wrote papers and reports for it. As a pioneer in the work of technical education, Mr. Rigg's name will long deserve to be remembered in this country. Mr. G. Yapp died in November, and in him the *Journal* lost a useful correspondent, and the Society one who had often taken an active share in much of its work, especially in such as related to exhibitions. Frank Buckland was not a member of the Society of Arts, but he was well known in it, and had frequently assisted in its work. The first Juvenile Lectures of the Society were given by Mr. Buckland, and he, on several occasions, read papers here, and otherwise took part in our labours. Mr. Mechi was an old and valued member of the Society, and had served both on the Council and on various committees.

His labours for the promotion of scientific agriculture are well known, and the Council are glad to learn that, though Mr. Mechi left but a small provision for his wife and family, this is now being supplemented by liberal subscriptions. Dr. Stenhouse, who died at an advanced age in December, was another member of the Society well-known in the scientific world. He, too, had read papers here. Mr. William Arnot died rather suddenly, and, indeed, only a little while before his death his name had been put down for the reading of a paper on his own special subject, the manufacture of paper. The members will recollect the excellent series of Cantor lectures which was delivered before the Society in 1877 by Mr. Arnot. Professor Tennant was a very old member of the Society, and a very valued member. He was a frequent attendant at our meetings, and was at all times ready to assist whenever his special knowledge or the collection which he had formed were likely to be of service to the Society. The Earl of Caithness, who died in March, had been a member of the Society since 1851, and at one time had been vice-president. Lord Caithness then took an active interest in the Society's work. The last time of his attendance at a meeting was when Professor Bell read his first paper on the Telephone here, on which occasion Lord Caithness was the first to hear the actual working of the instruments, which were separated by the distance, then thought remarkable, of over a mile, between the Society's house and the printing office in Fleet-street.

XXX.—The New Council.

The four senior vice-presidents, who were compelled to retire this year under the bye-law which regulates the constitution of the Council, were Lord Granville, Lord Northbrook, Sir John Lubbock, and Mr. Edwin Chadwick, all of whom have, in different ways and on different occasions, rendered valuable service to the Society. The last-named, Mr. Edwin Chadwick, has, as the members are well aware, been the main promoter of many schemes which have been brought forward through the agency of the Society. In their place the Council now put forward for election the Duke of Buccleuch, one of the oldest members of the Society, since he was elected in 1838; the Duke of Marlborough; Sir Richard Temple, whose able paper on "Forest Conservancy in India," attracted so much attention when read in the Indian Section last year; and Dr. Richardson, who was one of the retiring members of the Council. Besides Dr. Richardson, Mr. G. C. T. Bartley, Mr. Brudenell Carter, Mr. Henry Doulton, and Rear-Admiral Mayne, were removed from the list, either by seniority or by least attendance. In their place the Council now propose for election, Lord Alfred Churchill, who has been off the Council for a year, but whose name the Council feel sure the members will gladly see restored once more to its proper place in the list; Mr. George Matthey, F.R.S., the eminent metallurgist; Admiral Sir Edward Inglefield, C.B., F.R.S., who served once before on the Society's Council; Dr. E. Frankland, the distinguished chemist; and Mr. Loftus Perkins, who is well known for his investigations in high pressure steam-engines.

XXXI.—List of Members.

There can hardly be any better sign of prosperity than an increase in the list of the Society's members, and it is satisfactory to be able to state that such an increase has occurred during the past year. During the year 1880-81, 323 members have been removed from our list by death or resignation. During the same period 370 have been elected. There is, in consequence, an increase of 47. The total number of life and subscribing members is 3,302. There are also 37 institutions which subscribe to the Society from their own funds. This makes a total of 3,339.

XXXII.—Finance.

In accordance with the Society's bye-laws, the annual statement of receipts, payments, and expenditure for the past year was published in last week's *Journal*, in order to give members the opportunity of informing themselves as to the state of the Society's finances before attending the Annual General Meeting. An examination of this statement will show that the finances of the Society are in a thoroughly sound condition, and that the Society is as flourishing as ever it was. It was stated in last year's report that earnest efforts had been made during the year then passed to pay off a certain amount of floating debt, which had been in existence for many years. This was done, and the finances having once been placed on this satisfactory footing, it now only remains to keep them in the same condition, by a careful watch over the various items of expenditure, and by equal care as regards the sources of revenue of the Society.

It may now be well to glance through the various items of the financial statement. Beginning with the debtor side, we find that the amount of subscriptions received during the year was £6,005 10s., and it is not a little remarkable that this item almost exactly coincides with the similar item of last year, £6,005 8s., there being only a difference of two shillings. The amount of life compositions last year was very high. It was £567. This year, however, it has been exceeded, for we have had £609 contributed in this way. The total receipts from subscriptions during the year are, therefore, just £42 more than they were last. Although this difference is slight, it is gratifying to see that the difference is one of increase. The amount received by the Society's dividends and interest is a little larger this year than last—£647 against £626. This is due to the additional investments which have been made by funding the life subscriptions. The next item on this side of the account which calls for remark is the advertisements. Here we are compelled to acknowledge a falling off, the receipts having been £1,457 in 1881, against £1,604 in 1880. This must be attributed to the rather stagnant condition of trade of late years, and it is to be hoped that this item of revenue will soon recover itself. The receipts from sales are about the same as last year. They include the proceeds of the sale of some of Barry's etchings. Some sets of these interesting pictures still remain in the Society's possession, and they can be sold to members at the cost of ten guineas. In this year's statement the Society has not to account for any funds which, as frequently happens, have been entrusted to it for distribution. There is, therefore, no item like the £100 received from Mr. Watherston last year, for his prize on silversmith's work. The total receipts of the year 1881 are £9,485; those for last year

were £9,744; the difference being due to the falling off in the advertisement receipts, and to the fact that in last year's account the £100 Watherston prize above referred to appeared.

We may now turn to the credit side. Taking the items in the order set down, we find, under the first head, "House and Premises," a heavy charge for the alterations in the drainage, and for the new lavatory. This brings the total amount under this head up to £459; the corresponding head for repairs and alterations last year was £166, so that it will be seen there have been paid during the present year £338 more under this head. Although this is a heavy charge, it was a necessary one. Some particulars about it are given in the body of the Report. The item "Salaries and Wages" for the present year, is £47 heavier than last. This excess is due to a necessary addition to the clerical staff of the establishment. The charge for cleaning Barry's pictures appearing in the present statement is, of course, a special charge for this year only. The charge for stationery, printing, &c., is £53 less this year, but this is merely due to arrears of payment having been made up during 1880. The same reason accounts for the *Journal* having cost £426 more in 1880 than 1881, the total cost of this important part of the Society's operations being £2,016 this year. The charge for advertisements is £92 less this year, as was of course to be expected from the receipts from the same source being less. The examination charges show a considerable reduction this year, for they were £187 more in 1880 than in the present year. This of course is due to the alteration in the system of examinations. The Conference on Public Health, held in 1880, the payments for which were made during the financial year just ended, cost the Society £105, the similar Conference the previous year cost the Society £258, so here we find a reduction of £153. For the Domestic Economy Congress, just held, £73 have been paid; the remaining expenses for this will appear in next year's financial statement. The item for the Albert Medal deserves a word of explanation. It happens that the medal for the year before last, as well as for last year, was paid for during the past financial year, the presentation of both of them having been made by H.R.H. the President at the same time. Under the head of prizes, we find last year the Swiney Prize of £100, and Mr. Watherston's prize, also £100. There is, therefore, a difference of nearly £200, actually £195, in consequence of the new Prize for House Sanitation, on which some small expenses have been incurred. The amount spent on Cantor lectures this year is £10 less than that spent last. These charges are defrayed, as the members are aware, out of funds left by Dr. Cantor to the Society. The National Training School for Music again appears for the sum of £164, but it is not expected that any charge under this head will recur. The Art-Workmanship Exhibition is down for the small charge of £5. The principal charges for this will appear next year; it is not supposed that they will exceed some £50. In last year's statement, we find a sum of £196 put down for payments on account of the Artisan Reports on the Paris Exhibition of 1878. This being the last payment in this matter, there is, of course no corresponding item in the present year's statement. The total amount expended by the Society was £8,716; the amount last year was £9,297. It will thus be seen that in the present year there has been expended £581 less than last year.

We now proceed to consider the assets and liabilities of the Society. Here, again, we find a very satisfactory state of things. The excess of assets over liabilities last year was £7,735; for the present it is £8,617, showing a difference to the good of £882. Amongst the liabilities, the tradesmen's bills, due at the present time, are £74 more than last year. The alteration in the examination system has reduced the amount due to the Examiners from £188 in 1880 to £54 in 1881, the difference being £134, while the £42 set down as liabilities for two medals in the 1880 statement, have been paid, and therefore no liability appears at present under this head. As to the Society's assets, our invested funds have been increased from £3,571 in 1880, to £4,344. The subscriptions of the year uncollected are £61 less than last year—£749 against £810; while it is a healthy sign, also, to note that the arrears are not quite so heavy, and may be estimated at £300, instead of £350. The property of the Society is put down at the moderate estimate of £2,000. The same cause which has reduced the actual earnings for the *Journal* advertisements during the year has also lowered the amount set down as an asset under this head. We have now £1,256 which we may expect to obtain, against £1,477 last year. The Trust Funds in the charge of the Society are set out at length in the statement. The principal of these is Dr. Cantor's bequest, £5,052, the interest of which is devoted to the popular Cantor lectures. The next in amount is the bequest of Dr. Swiney, £4,500. This is chargeable with the sum of £200 once in five years, £100 of which is expended upon a silver goblet, and the other £100 presented with the goblet to the author of the best published work on Jurisprudence. Alfred Davis's bequest is £1,800. The income of this is to be applied for the general purposes of the Society. The following Trust Funds are chargeable with the award of medals or money prizes out of the interest resulting from them:—

John Stock	£100
Benjamin Shaw	133
North London Exhibition	157
Fothergill	388
Dr. Aldridge	90
Thomas Howard	500
Owen Jones Memorial	400

The Mulready Trust of £109 is charged with the expense of preserving in order the tomb of that artist in Kensal-green Cemetery. The amount of subscriptions for the Memorial Window in St. Paul's Cathedral, £345, is being held by the Council until some decision on the subject has been arrived at. The amount of £100, given as a prize by the late Sir Walter Trevelyan, as stated above in the section of the report dealing with the Food Committee, has been placed on deposit with Messrs. Coutts. There is also an amount of £525 subscriptions to an endowment fund, and a sum of £50 given by Mr. Murray as a nucleus for a building fund.

The Chairman, in moving the adoption of the report, referred to some of the chief points contained in it. He said that the award of the medal to Dr. Hofmann would give the greatest satisfaction both in Europe and in America. As to the Patent Bill, now being drafted, he could not say that they would be able to pass it, but it would go forth as a Bill which the Council thought ought to be passed. He must acknowledge that he was horrified at the particulars which were stated at the meetings of the Committee on Poisonous Colours. There he learned that the green of the ordinary venetian blinds was often obtained by the use of arsenic in the paint, and that, after having been dried by the sun, these blinds threw off a considerable amount of arsenical dust to poison the air of the room. He could tell the members present, with regard to the pictures on the walls, that no mother washed her first child with greater care than was taken by those who undertook the responsibility of cleansing Barry's pictures. He then made a few remarks upon the reduction of the price of telegrams, upon house sanitation; and alluding to the Food Committee, of which Professor Huxley had consented to act as chairman, said that any body with which that gentleman was connected was sure to do good work. In conclusion, he expressed the opinion that the details given under the head of finance, would make the items of receipts and expenditure intelligible to many who found some difficulty in thoroughly understanding a balance-sheet.

Mr. W. S. Rumsey seconded the adoption of the report.

Mr. Campin objected to the paragraph in the report on the Patent-law, as no notice was taken of previous workers. He thought Mr. Anderson's Bill was satisfactory, and that it would have been better to have supported that than to bring in a Bill that was not likely to pass.

Mr. Hale objected to the time of meeting, and thought the discussions should be more fully reported. The mode of election to the Council needed revision, so that there might be a more general selection from among the members.

The report was then agreed to.

The Chairman declared that the following had been elected to fill the several offices.

The names in *italics* are those of members who have not, during the past year, filled the offices to which they have been elected.

President.

H.R.H. the Prince of Wales, K.G.

Vice-Presidents.

H.R.H. the Duke of Edinburgh, K.G.
H.R.H. Prince Leopold, Duke of Albany, K.G.
F. A. Abel, C.B., F.R.S.
Sir Rutherford Alcock, K.C.B.
F. J. Bramwell, F.R.S.
Sir Thomas Brassey, K.C.B., M.P.
Duke of Buccleuch, K.G., F.R.S.
Sir Henry Cole, K.C.B.
Sir T. Douglas Forsyth, K.C.S.I., C.B.
Capt. Douglas Galton, C.B., F.R.S.
Sir Frederick Leighton, P.R.A.
Duke of Marlborough, K.G.
W. H. Perkin, F.R.S.
Robert Rawlinson, C.B.
Lord Reay.
B. W. Richardson, M.A., M.D., F.R.S.
C. W. Siemens, LL.D., F.R.S.
Earl Spencer, K.G.
William Spottiswoode, LL.D., P.R.S.
Right Hon. J. Stansfeld, M.P.
Duke of Sutherland, K.G., F.R.S.
Sir Richard Temple, G.C.S.I., C.I.E., D.C.L.

Ordinary Members of Council.

George Birdwood, M.D., C.S.I.
Andrew Cassels.
Lord Alfred S. Churchill.
Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E.
Lieut.-Col. Donnelly, R.E.
Edward Frankland, D.C.L., F.R.S.
Admiral Sir Edward Inglefield, C.B., F.R.S.
G. Matthey, F.R.S.
Admiral Sir F. W. Nicolson, Bart., C.B.
Loftus Perkins.
W. H. Preece, F.R.S.
Lieut.-Colonel Webber, R.E.

Treasurers.

B. Francis Cobb.
Owen Roberts, M.A.

Secretary.

H. Trueman Wood, B.A.

Mr. Liggins thought the reason why these annual meetings were not more fully attended, was that members were quite satisfied with the conduct by the Council of the Society's business. He then drew attention to Mr. Hyde Clarke's letter in the *Journal* of June 10, on the "Manufactures, Trade, and Progress of England," and suggested the appointment of a committee by the Council on this subject.

Mr. Christopher Cooke referred to the erection of memorial tablets, and suggested some additional houses upon which they might be set up.

Mr Hyde Clarke urged that some action should be taken to preserve the trade which was being wrested from Englishmen by foreigners, and that more attention should be paid to British commerce abroad. He thought a committee appointed by the Council might do much for the improvement of the present state of manufactures.

Mr. Christian Mast supported Mr. Clarke's proposal, which he considered to be one of the greatest importance.

Mr. Pfoundes said that he considered this a most practical proposal; and from his own experience he could say that, if the suggestion was carried out, the members of the Consular service would be greatly helped by such action.

Mr. Pagliardini thought that Mr. Clarke should read a paper on the subject early next Session. He also suggested that a tablet should be erected on the house, No. 20, Bentinck-street, where Gibbon wrote his history.

Mr. Hyde Clarke could not agree with Mr. Pagliardini, as he considered his proposal was one to which immediate attention should be given.

A vote of thanks to the Scrutineers, moved by the **Chairman**, and seconded by **Mr. Rumsey**, was carried unanimously.

A vote of thanks to the President, Vice-Presidents, Council, and Officers (especially to the retiring members of Council and to the Chairman), proposed by **Mr. Hyde Clarke**, seconded by **Mr. Hale**, and supported by **Mr. Campin**, was carried unanimously.

Mr. Bramwell returned thanks, and the meeting adjourned.

MISCELLANEOUS.

NOTES ON GUMS, RESINS, AND WAXES.

By C. G. Warnford Lock.

The following economic notes, from the journals of recent travellers, seem worthy of reproduction in a collective form:—

Senegal Gum.—The product of acacias which grow

in the neighbourhood of the Sahara. During the harmattan winds, the gum exudes from the bark of the trees in tears, and solidifies in the open air, the amount of exudation depending upon the force and duration of the wind. The production in 1871 was 3,161,906 kilo. (of 2·2 lb.).

Mpafu.—A large tree yielding a sweet-scented gum-resin, much valued by the natives on the Victoria Nyanza.

Gum Arabic is produced by *Acacia gummifera* (*Mimosa gummifera*, *Acacia coronillæfolia*, *Mimosa coronillæfolia Sassa gummifera*), a scarcely known plant of Morocco, occurring abundantly as a thorny bush in the lower region of south and west Morocco, according to the testimony of the natives, who call the plant *alk tlah.* The gum does not seem to be collected in the western portion of its range in south Morocco, but in Demnet, whence it is carried to Mogador. Possibly it is only in the hotter and drier regions of the interior that the gum is produced in quantities to be worth gathering. At any rate, its gum is yielded only during the hot, parching months of July and August, and increases according to the hotness of the weather and the sickly appearance of the tree, being least after a wet winter and in a mild summer.

Some accounts suppose the Moroccan gum Arabic to be derived from *Acacia arabica*, which is found in Senegal; but all the inquiries made by Consul R. Drummond Hay, for Hooker and Ball, agree that this plant, the *alk awarwhal* of the Arabs, is not found in Sus, no such tree existing either north or south of the Atlas Mountains, its gum being brought from Soudan, and of inferior quality to that of *A. gummifera.* It is further stated that this latter species grows chiefly in the provinces of Blad Hamar, Rahamma, and Sus.

Elemi.—This used to be brought in large cakes to Bembe (West Africa), and is said to be very abundant at not many days' journey.

Jutahy-seca.—A resin or gum which exudes from the bark of the jutahy tree of Brazil (*Hymenœa mirabilis*); universally employed for varnishing native pottery.

Copal.—Red gum copal is almost entirely the product of the Mossulo country (Angola), though it exists farther north, as at Mangue Grande. Until 1858, it was a principal export from Ambriz to America, but the war stopped it. According to native accounts, it is found below the surface of a highly ferruginous hard clay, at a depth of a few inches to two feet. It probably extends much deeper, but the natives are too lazy to look for it. It occurs in irregular flat masses up to several lbs. The natives only dig for it during and after the last and heaviest rains in March—May, and restrict the export to maintain the price. No trees and but little grass grows over the spots. The tree is said to be abundant in the woods adjoining the inner side of the wilderness in Usambara (East Africa), but does not extend farther inland.

A great staple of the district traversed by the newly-made road from Dar-es-Salaam, through the Wazamaro country, is gum copal, which is found in many parts. This fossil resin seems to exist, even in the richest diggings, only in patches, as though it were produced by isolated trees. The natives appear to work the country nowhere systematically; they sink test-holes, and, on finding traces of the resin, work that part thoroughly. In many places, test-holes have been made and the place abandoned as useless, although not far off a patch has been well worked. The fossil resin, now found underground usually in red sandy soil, is undoubtedly the produce of the same species of tree as still exists in these jungles, and which now yields an inferior sort of resin. The difference between the two products seems to arise from chemical or molecular change effected by time. The copal tree grows throughout the Uzamaro country, and is by no means confined to the sea coast, but is even more abundant inland beyond the first coast-ridge. It is not seen, however, where the old limestone formation of the interior makes its appearance.

Chian Mastic.—The mastic country of Chios is usually flat and stony, with little hills intervening, and with rare streams. Rain is destructive of the harvest; frost is rare, but much to be feared. The resin is a product of *Pistachia lentiscus.* The principal villages engaged in the industry are Calimassia, Saint Georges (south of Anabato), Nénita, Mesta, and Kalamoti, besides which there are about a dozen of minor importance. The mastic occurs in white grains, varying in size from a pin's head to a pea. The shrubs yielding it are about the height of a man. It occurs also in Africa and Arabia, but always of inferior quality, though no satisfactory reason has yet been adduced for the fact. In July—August, a great number of incisions are made in the stems of the shrubs, and renewed three or four times. Repeated visits are then made to collect the resin which exudes. A shower of rain during this period produces disastrous results, by washing away the resin. There are four qualities of mastic:—(1.) Cake mastic is composed of large pieces, and is considered the best by connoisseurs; it is sold chiefly for use in the seraglios, all Turkish women chewing mastic; its price is 120 to 130 piastres, and even more, per oke of 1,300 grm. (2.) Mastic in large tears is worth 90 to 100 piastres ordinarily. (3.) Mastic in small tears or pearls is worth 70 to 85 piastres, and is used industrially. (4.) Mastic mixed with fragments of leaves and sand is used to make so-called "mastic brandy," the well-known Turkish liqueur, called *raki.* It is made by digesting mastic in the brandy obtained from dry grapes, redistilling the product, and flavouring with aniseed and sugar. The best qualities of mastic are used in the Levant; Europe imports the inferior grades for making varnish.

Chian Turpentine.—Afforded by *Pistachia terebinthus.* That which exudes from the shrub is very white and aromatic, but the quantity is very limited.

India-rubber (from *Ficus elastica*).—The collection of the rubber in Assam is conducted under rigid restrictions in the case of all trees growing in the timber reserves, but cannot be enforced on scattered trees. The Chárdwár rubber plantation has an area of 80 square miles. The exports from Lakhimpur in 1871 were 260⅝ tons, value £8,340. Immense forests of these trees existed on both banks of the Subansiri river, and on other streams, but the reckless treatment they received from native lessees of the forests caused their ruin. In 1876, the leasing of these forests ceased, but there is now little or no rubber left in the plains of the Lakhimpur district. The tree grows to heights of 15 to 35 feet, and its girth, when fit to be tapped, is 18 inches to 6 feet. A high yield for the first tapping of a tree is 35 to 40 lbs. of rubber. It is then allowed to remain untouched for three or four years, when another collection is made, but the yield is then much less. It is estimated that the forests of Cachar could yield upwards of 2,000 cwt. of rubber annually. It is stated that the trees yield most during the rains.

Of india-rubber, 20,000,000 lbs. are annually exported from Pará (Brazil), chiefly derived from *Siphonia elastica*, but a few other species are admitted. The utmost yield from each tree is one gill. In the wet season, from February to July, the gum is weak, and the tapping is stopped. The trees will grow on the *terra firme* when planted, but their seeds naturally lodge in lowland swamps. Trees properly planted and cared-for yield well in fifteen years. Brazil is being gradually cleared of its rubber; gatherers now go to the Tocantins, Madeira, Purus, and Rio Negro, and will soon clear there also. Straus's method of preparing rubber, instead of smoking, is to drop the milk into alum solution; it is stated to be superior, but is not adopted.

India-rubber plants grow on the slopes of the Cameroons mountains (West Africa), but the people

do not yet know their value. India-rubber trees abound on the River Djour, in the province of Bahr el Ghazal. The natives of the Marutse-Mabunda empire, on the Upper Zambesi, trade in india-rubber with the tribes to the west.

The *Landolphia* vine is known from Pangani inland all the way to Handei (in Usambara, East Africa), and at Magila the rubber is made into balls for export.

The giant creeper, *Landolphia*, grows chiefly on trees near rivers and streams in Angola and the Congo. Every part exudes a milky juice when cut or wounded, but this will not run into a vessel placed to catch it, as it dries so quickly as to form a ridge on the wound, which stops its further flow. The blacks collect it by making long cuts in the bark with a knife, and as the milky juice gushes out, it is wiped off continually with the fingers, and smeared on their arms, shoulders, and breast, till a thick covering is formed. This is peeled off their bodies and cut into small squares, which are then said to be boiled in water. From Ambriz the trade in this rubber quickly spread south to the River Quanza, where considerable quantities are exported.

Within 20 miles of the coast from Liawa and the Lindi estuary (Masasi and Rovuma, East Africa) the forest becomes almost entirely formed of india-rubber vines, affording an abundant supply of fine india-rubber, at present gathered only in a very desultory manner by the natives, who gash the plants, and collect the rubber as it issues in a liquid form, and dries hard after short exposure to the air. Rolled into orange-like balls, it is taken to Lindi, where what is worth 7 to 8 dols. fetches 2 dols. The width of the belt is 15 to 20 miles. On the Victoria Lake (Central Africa) are one or two kinds of tree which produce caoutchouc of good quality.

Dr. Kirk has just determined, with accuracy, the plant which yields the best East African india-rubber, and has obtained seeds of the species for introduction into India. It occurs in great abundance along the newly-made road from Dar-es-Salaam, in a west-south-westerly direction, for about 100 miles towards the interior of East Africa, through the Wazamaro country; it is apparently but little affected, except in the immediate neighbourhood of the villages, by the reckless mode of tapping employed. In many parts, a native can still collect 3 lb. of rubber daily. There are five species, but only one is considered worth tapping.

Rubbers and Guttas of Borneo and Sulu.—The Kadyans and their Murut neighbours collect a quantity of gutta-percha and india-rubber in the surrounding forests. The gums are afterwards manufactured into lumps or balls, and conveyed to Labuan for sale. The gutta is obtained from four or five species of the genus *Isonandra*, all large forest trees. The trees are felled and their bark is girdled or ringed at intervals of two feet, the milky juice or sap being caught in vessels formed of leaves or coco-nut shells. The crude juice is hardened into slabs or bricks by boiling, and is generally adulterated with 20 per cent. of scraped bark. Indeed, it is said that the Chinese traders, who buy up the gutta from the gatherers, would refuse the pure article in preference for that containing bark, to which the red colour is mainly due.

India-rubber in the north-west districts of Borneo is the produce of three species of climbers, known to the natives as *manoongan*, *manoongan putih*, and *manoongan manga*. Their stems have a length of from 52 to 100 feet, and a diameter rarely exceeding 6 in.; the bark is corrugated, and coloured grey or reddish-brown. The leaves are oblong, green, and glossy; the flowers are borne in axillary clusters, and are succeeded by yellow fruits, of the size of oranges, and containing seeds as large as beans, each enclosed in a section of apricot-coloured fruit. These fruits have a delicious flavour, and are much prized by the natives. The stems of the india-rubber creepers are also cut down to facilitate the collection of the creamy sap, which is afterwards coagulated into rough balls by the addition of nipa salt.

The fallen gutta trees lie about in all directions in the forest, and the rubber-yielding *Willughbeias* are also gradually, but none the less surely, being exterminated by the collectors in Borneo, as throughout the other islands, and on the Peninsula, where they likewise abound.

It was formerly thought that gutta-percha was the produce of only one species of tree (*Isonandra Gutta*), but that obtained from the Lawas district is formed of the mingled saps of at least five species, the juices of a *Ficus*, and of one or two species of *Artocarpeæ*, being not unfrequently added as adulterants. The Bornean *gutta soosoo*, or india-rubber, again, is the mixed saps of three species of *Willughbeia*, with the milks of two or three other plants surreptitiously introduced to increase the quantity.

The gutta trees are slow to attain maturity, and are difficult to propagate, except from seed. The *Willughbeias*, on the other hand, grow rapidly, and readily lend themselves to both vegetative and seminal methods of propagation; hence these are especially deserving of the attention of the Government of India, where they may reasonably be expected to thrive.

There are, doubtless, yet many thousand tons of rubber and gutta in the Bornean woods, but as the trees are killed by the collectors without any thought of replacing them, the source of supply must recede constantly farther from the markets, and prices will rise in consequence. The demand for india-rubber from Borneo is of quite recent growth, yet in many districts the supply is already practically exhausted.

In Assam, Java, and Australia, rubber is afforded by *Ficus elastica*, which is cultivated for the purpose. There are many milk-yielding species of *Ficus* in the Bornean forests which, with careful experiment, may possibly be made to contribute remunerative quantities. The Malayan representatives of the bread-fruit family also deserve examination, as an excellent indiarubber is derived from *Castilloa elastica*, a South American plant of this order.

Lac.—Secreted by an insect (*Coccus lacca*), on the branches and twigs of certain jungle trees, principally *khusum* (*Schleichera trijuga*), *plas* (*Butea frondosa*), and *bier* (*Zizyphus jujuba*). The lac from the first is more esteemed than that from the others. To some extent, the lac is found occurring, so to speak, spontaneously, and is collected by forest tribes, and brought by them to the fairs and bazaars for sale. Where, however, there is a regular trade in stick-lac, propagation of the insect is steadily carried on by those who wish for a certain and abundant crop. This propagation is effected by tying small twigs, on which are crowded the eggs or larvæ of the insect, to the branches of the above-named species of trees. These larvæ are technically called seed. The larvæ, shortly after sowing, spread themselves over the branches, and, taking up position, secrete around themselves a hard crust of lac, which gradually spreads till it nearly completes the circle round the twig. At the proper season, the twigs are broken off, and on arrival at the factory, are passed between rollers, which admit of any degree of approximation. The lac is thus crushed off, and is separated from the woody portion by screening. It is next placed in large tubs half full of water, and is washed by coolies, who, standing in the tubs, and holding on to a bar above by their hands, stamp and pivot about on the heels and toes, until, after a succession of changes, the resulting liquor comes off clear. The lac having been dried, is placed in long cylindrical bags of cotton cloth of medium texture, and about 10 ft. long and 2 in. in diameter. These bags, when filled, are taken to an apartment where there are a number of open charcoal furnaces. An operator grasps one end of the bag in his left hand, and slowly revolves it in front of the fire; at the same time, an assistant, seated at the other end of the bag, twists it in the opposite direction. The roasting soon melts the lac in the bag, and the twisting

causes it to exude, and drop into troughs placed below, which are often only the leaves of *Agave americana*. When a sufficient quantity in a molten condition is ready in the trough, the operator takes it up in a wooden spoon, and places it on a wooden cylinder, some 8 to 10 inches in diameter, the upper-half of which is covered with brass—in some places the freshly-cut, smooth, cylindrical stem of the plantain is used for this purpose. The stand which supports the cylinder gives it a sloping direction away from the operator. Another assistant, generally a woman, now steps forward with a strip of *agave* in her hands, and with a rapid and dexterous draw of this, the lac is spread at once into a sheet of uniform thickness, which covers the upper portion of the cylinder. The operator now cuts off the upper edge with a pair of scissors, and the sheet is lifted up by the assistant, who waves it about for a moment or two in the air, till it becomes quite crisp. It is then held up to the light, and any impurities, technically "grit," are simply punched out of the brittle sheet by the finger. The sheets are laid one upon another, and, at the end of the day, the tale is taken, and the chief operator is paid accordingly, the assistants receiving fixed wages. The sheets are placed in packing-cases, and when subjected to pressure, break into numerous fragments. In the fresh state, the finest quality has a rich golden lustre.

The dark-red liquor before referred to, as resulting from the washing, is strained, in order to remove all portions of woody fibre and other foreign materials. It is then passed into large vats, where it is allowed to settle; the sediment is subjected to various washings, and at last allowed to settle finally, the supernatant liquor being drawn off. The sediment, when of the proper consistency, is placed in presses, from which it is taken out in the form of hard, dark-purple cakes, with the manufacturer's trade-mark impressed upon them. This constitutes what is known as lac-dye. The dye which is thus separated from the lac by washing is said to be the body of the insect—not a separate secretion.

It might appear that some mechanical arrangement would be more efficacious and economical for washing and separating the lac from the dye, but human labour is so cheap, that this is not the case. The daily pay of the women is 1d. to 1½d.; of the men, 1½d. to 2d. No evil effect on the feet of the stampers is to be observed. The great and sudden oscillations of price in the London market render this trade very risky, and the aniline dyes have well-nigh rung the knell of lac-dye in European industry.

In Assam, a small quantity is produced in the district of Darrang. In some districts, the insect is artificially reared on the *jhuri* tree (*Ficus cordifolia*).

Indian White Wax.—This is produced by the female of the *Ceroplastes ceriferus*, an insect allied to the *Pela* of the Chinese, whose product is so largely used for making candles for the Buddhist temples. The Indian insect deposits its wax in small masses upon the twigs and branches of several trees, but more particularly on the *arjun* (*Terminalia Arjuna*); it does not appear to have ever been propagated, nor has the wild product been collected in quantity. Though an article of undoubted value, it would perhaps scarcely repay expenditure of European time and capital; but the natives might surely render its cultivation a very profitable undertaking. The wax is soluble, or nearly so, in boiling alcohol, also in benzine and ether, but only very slightly in turpentine and carbonic disulphide ($C S_2$). Its composition is $C_{13} H_{26} O$. It is found at many widely-distant points throughout Sirguja, and is abundant, and suitably situated for experimental cultivation, on the *arjun* trees growing upon the embankment of the Purulia lake.

The Gum Trade of Somali Land (East Africa).—The gum, or *habak*, always sold in grades, bears the name of *ankobib*. On sifting, it is always found mixed with a small quantity of other sorts which make weight in the balance; these are the *habak euddé* and the *habak follaïa*. The incense, or *luban*, sold in grades, takes the name of *beïho*. The *saphi*, or "triage," is divided into three qualities. The 1st, *fasous*; the 2nd, *nagoua*; the 3rd, *medjigel*. The *saphi*, or "triage," is made into *doukans*, when the arrivals are not too great, by women and children, who are paid about 6d. a day.

The myrrh has but one quality, but it is necessary to be on the guard against the admixture of false myrrh, of the same colour, but more powerful odour, which the Arabs call *addi*. It is easy to recognise this latter, which always appears oily.

The *maïdi*, called in Europe "gum elemi," is a kind of incense in large bleached tears. It presents the same grades as incense, and buyers aim especially at preserving the tears unbroken to heighten the value.

The *alet*, or *mourcoud*, is a grey gum, with an exquisite odour recalling that of ambergris.

The *addi*, or false myrrh, whose odoriferous wood is mixed with the wood of *djirmeh*, has an odour when burnt closely resembling that of "seraglio pastilles."

The *fallah-fallah* is a resinous bark, which is burnt to give off a peculiar odour, under the name of *habak droun*.

Statistics of the annual receipts of gums and incenses at the ports of the Medjourtine coast:—

	Bohars.
Bender Ziyâda	250
Bender Gâsem	1,200
Abou Régabé, Bender Baad	900
Borah	300
Gandala	500
Bender Khor	1,000
Râs Orbé	250
Merâya	1,500
Guersa	200
Guesli	400
Bender Felik	700
Atloûla	1,000
Total	8,200

The bohar is equal to 136 kilo., or, say 8,200 bohars are about 1,200 tons; this increases to 2,000 tons in a good year.

Myrrh reaches two places only—

Bender Gâsem	30 Bohars.
Borah	3 ,,

Haffoûn, in 1877, received 25 bohars.

Magnificent incense-trees, two to three feet in diameter, are found on the lofty mountains towards the north coast of Somali Land. Mareyeh, an important village, lying over 30 miles west of Cape Gardafui, has a large export of myrrh and incense.

Obeidh, the capital of Kordofan, is the centre of a large trade in gum, which is collected in the woods by the women and children, and taken to their villages, where it is disposed of to petty itinerant traders, for ultimate dispatch to Europe.

Moroccan Gum Ammoniacum (which must not be confounded with the Persian product of *Dorema Ammoniacum*, or *ushak*), is an object of commerce with Egypt and Arabia, where it is employed, as of old, in fumigating. The plant affording it is called *fashook* in Arabic, and has been hitherto referred to *Ferula orientalis*, or *F. tingitana*; but Ball and Hooker consider it decidedly an *Elæoselinum*, probably *E. humile*. Leared was told that this plant grows at a place two days from Mogador, on the Morocco road; but Hooker and Ball were assured that it is found nowhere along that route, nor nearer to it than El Araiche, a place lying north of Morocco city, which is confirmed by information gathered by R. Drummond Hay, to the effect that it occurs near Morocco, and chiefly around Tedla.

Gum Sandarach is a product of *Callitris quadrivalvis* (*Thuja articulata, Frenela Fontanesii*), a tree indigenous

to the mountains of North Africa, from the Atlantic to East Algeria, its eastern limit being undertermined. The resin, once a reputed medicine, is collected by the Moors, and exported from Mogador to Europe, where it is used in varnish-making.

Euphorbium gum is produced by *Euphorbia resinifera*, a tree confined to the interior of Morocco. The juice flows from incisions made with a knife, and hardens and drops off in September, the produce being abundant only once in four years. The people who collect the gum tie cloths over their mouths and nostrils, to exclude the small dusty particles, which provoke intense sneezing. The gum once had a wide medicinal use, but the trade in it is now rapidly declining, and its consumption is restricted to veterinary practice, and as an ingredient in a marine paint.

CASTOR OIL GAS-WORKS AT JEYPORE.

A report by Major S. S. Jacob, on the Jeypore Oil Gas-works, an establishment founded by the late Maharajah of Jeypore, is quoted in the *Journal of Gas Lighting*. From the memorandum on the working of the establishment prepared by the present manager (Mr. S. J. Tellery), whose administration is highly commended by Major Jacob, it appears that the gas is principally produced from castor oil, with the addition, when the castor seed is not available, of poppy, til, or rape seed. According to Mr. Tellery's own records, he produces from one maund of castor oil (82 lbs.) about 750 cubic feet of 26½-candle gas; or 1,000 cubic feet of 18½-candle gas; or 1,250 cubic feet of 9-candle gas. With other oils the same quantity of material worked to make gas of equal qualities will produce 610 cubic feet, 762 cubic feet, and 914 cubic feet of the respective grades of illuminating power. According to these results, taking the current prices of oils delivered into the works—castor oil being Rs. 11 12a. (22s. 4d.), and the other oils Rs. 10 (19s. 10d.) per maund—the castor oil gas is Rs. 0 10a. 4p. (1s. 3d.) per 1,000 cubic feet cheaper than other oil gas. The works are double in all respects, duplicate sets of retorts, purifiers, &c., and gasholders being erected, for which arrangement no reason is given. At present two horizontal retorts are used, which are kept at work during about 218 hours per month, and produce something like 98,720 feet of gas in this time. Worked in this way, the cost of manufacture (exclusive of the cost of oil) is as follows:—

	Rs.	a.	p.
Wear and tear..........	1	3	2¼
Fuel	2	11	7
Labour	0	5	3¼
Purification	0	0	4¼
Total cost per 1,000 cubic feet ...... =	Rs. 4	4	4¾, or 8s. 6d.

This high charge for manufacturing expenses is said to be due to the fact of so little gas being required; if the consumption should increase to about 260,000 cubic feet per month, which could be supplied without increased cost for establishment charges, the working expenses per 1,000 cubic feet would be reduced to Rs. 2 9a. 5¾p. (5s. 1d.). The gas is chiefly consumed in the public offices and streets; there are, however, a few private consumers, who are charged by meter at the average cost price, Rs. 18 1a. 8p. (35s. 10d.) per 1,000 cubic feet, and appear well satisfied with the supply. Most of the burners in use consume only 1½ cubic feet of gas per hour, which, with this rate of consumption, is equal to from 17 to 18 candles; the gas is therefore of high brilliancy. The street main from the works is 5 inches in diameter, which is considered ample for supplying 1,500 lights. One house in Jeypore has 118 lights supplied through an inch service-pipe. The loss by leakage is estimated at about 13 per cent. The supply of premises temporarily, or when situated at a distance, is provided by compressing gas at the works to about three atmospheres by means of a pump driven by one bullock. The compressed gas is then delivered in a wrought-iron receiver to the point of consumption, where it is either transferred into fixed receivers and burnt by the aid of suitable regulators, or is delivered into small portable or service gasholders, and burnt in the usual way. A *ghat*, or landing-stage, two miles distant, is thus supplied with 400 cubic feet of gas every day, which is consumed by 30 jets, each burning 1½ cubic feet per hour for nine hours. There have not been any accidents from the distribution of gas in the portable reservoirs, or otherwise. As railway carriages are also supplied with compressed gas, it is evident that the introduction of this branch of service has widely extended the utility of the establishment. Another peculiarity of the Jeypore undertaking is the necessity that exists for the manager to unite the attributes of a farmer to his other acquirements, for the purpose of securing a constant and cheap supply of raw material for gas-making. Last year Mr. Tellery personally superintended the sowing of 300 acres with the castor plant (*Ricinus vulgaris*), and the establishment includes a hydraulic oil-pressing apparatus. The process of extracting the oil for carbonising is as follows:—First, the castor seed is passed through the crusher, when the shells only are broken off. The shells are then picked out by hand, and the seed is again introduced into the crusher, where it is ground to a paste. It is then passed into the heating pan, and, after being well heated it is packed into horsehair bags and filled up hot into the press immediately. After about 20 minutes' pressing, the exuding oil being meanwhile collected, the cake is removed and ground over again. It is subsequently heated and pressed a second time, until about 33 or 40 per cent. of oil is obtained from the seed. The labour of preparing and pressing the castor seed costs Rs. 1 1a. 8p. (2s.) per maund of oil. The cost of extracting other seed oil is about the same, with the exception of the cost of removing the shells. For generating gas, the oil is used as it comes from the press. Formerly, at other places, when the oil-bearing seeds were carbonised for gas without previous treatment in this way, the product was overloaded with carbonic acid from the woody part of the seeds, and correspondingly heavy cost for purification was incurred, which by Mr. Tellery's process is entirely avoided. When the establishment was first started, the cost of manufacturing gas was Rs. 23 2a. 5½p. (45s. 10d.) per 1,000 cubic feet; but from the time when the present manager obtained full powers of working independently the cost has been reduced, over an average of six months' working, to Rs. 18 1a. 8p. (35s. 10d.) per 1,000 cubic feet. There will be considerable saving if the manager succeeds in his castor plantation, and he is confident that during the next twelve months the cost will be brought down to Rs. 13 or Rs. 14 (25s. 9d. to 27s. 9d.). The illuminating power of the gas is such, that a burner consuming 1½ cubic feet per hour is equal to 17 or 18 candles, and about 800 cubic feet of purified gas are usually produced from a maund of oil. As a further means of economy, it is proposed to erect an apparatus to burn the tar, which is rather a drug, for the preparation of lamp-black. This is expected to bring in a better profit than the present system of selling the tar at an almost nominal price.

MANILLA HEMP.

The following is a report from Surgeon-General Balfour to the Secretary of State for India, dated October 15, 1880:—

"Mr. Liotard, of the Agricultural Department of the Government of India, has this year (1880) reported on the materials in India, suitable for the manufacture of paper. Several of the fibre-yielding plants are mentioned

by him, and, amongst others, various species of the genus *Musa*, of the plantain or banana tribe, many of which have been grown in the East Indies from the most remote times. At pages 54 to 58, he describes the introduction, in February, 1858, of the Manilla hemp plant, direct from the Philippines, into the Madras districts, by Colonel (now Sir George) Balfour. Nevertheless, the Import Trade Returns of the United Kingdom show a large and continually increasing delivery of hemp from the Philippine Islands, now averaging yearly about 20,000 tons,* valued about half a million sterling. I have ascertained from the London produce brokers, through Dr. Birdwood, of the India Office, that this important article is the true Manilla hemp from the *Musa textilis*, that the bulk of it is delivered in London, where it is made up into cordage and ropes for ships, especially for yachts' running rigging, being very light, strong, and clean, and also for clothes lines. But there is no doubt that the Manilla hemp plant, *Musa textilis*, grows as well in British India as other species of the plantain or banana genus, and that British India could, in a couple of years, supply the London market with all that it could take of Manilla hemp fibre. The prospect of benefiting British India by creating an export trade from it of the extent and value above indicated might well incite to considerable efforts to attain success. In 1861 to 1863 the Madras Revenue Board made continuous efforts† to secure the naturalisation of the plants which Colonel Balfour had introduced, but their efforts seem to have been effectual only in the Wynaad, from which, by 1877, the Conservator of Forests replied that the Philippine variety had been introduced on several of the coffee estates, where it grows remarkably well, and no doubt is felt there as to the value of its fibre. The attention of the Boards and Commissioners of Revenue, and of the Agri-Horticultural Societies might be re-directed to this plant."

STEAM DIGGER.

Where labourers and workmen are continually striking for an increase in their rate of wages—even when, as has occurred recently at Goulburn, N.S.W., they are in receipt of no less than 12s. per day of eight hours—it is not surprising that mechanical inventiveness is stimulated in its efforts to supplant manual labour by machinery. One of the most recent evidences of activity in this direction is the "steam digger," which, first making its appearance at the Carlisle Show of the Royal Agricultural Society last year, has since then been subjected to practical trial. The inventors claim that the steam digger can dig an acre of ground in one hour at a cost of 5s.; in other words, that it can do work equal to the labour of 170 men in a day, or of one man in seven months, which labour would, at ordinary rates represent an expenditure of £21. Compared with the cost of ploughing, the digger gives the following results:—To plough ten acres in one day with the familiar horse-plough would require ten men and ten boys and thirty horses, at a cost of £6, and the estimated cost of similar work with the steam-plough is £4 5s., while the steam digger undertakes to perform the same amount of labour for £2 7s. It is also claimed that the machine produces superior cultivation, and that the "motor," when not employed in digging, may be used for other farm purposes, such as threshing and grinding. Recent public trials of the steam digger show that the machine will dig to any depth down to a foot. In working, a number of sharp-pointed spades are set in motion, digging into the earth and turning over the soil as cleanly and evenly as the most practised labourer. A space twenty-one feet in breadth is dug at a time; but the machine, when travelling along the roads, can be turned round "end on," and pass along any ordinary thoroughfare. On the vast areas of land in Australia, Canada, Cape Colony, New Zealand, and other of our colonies where labour is scarce, such a machine would be invaluable. It is equally efficacious on wet, dry, or even frost-bound soil.—*Colonies and India.*

GENERAL NOTES.

International Medical and Sanitary Exhibition.—This Exhibition, organised by the Committee of the Parkes Museum of Hygiene, will be opened on Saturday, July 16, and continue until August 13. The opening ceremony will take place in the Royal Albert Hall, at 4.30 p.m., and will be presided over by Earl Spencer, Lord President of the Council.

New Zealand Wool.—The total quantity of wool exported from New Zealand in 1879, amounted to 62,220,810 lbs., of the declared value of £3,126,439, against 59,270,256 lbs., of the declared value of £3,292,807, exported in 1878, an increase of 2,950,554 lbs. in quantity, and a decrease of £166,368 in declared value. The exports for the last seven years, ending respectively on the 30th September, were as follow:—

Year ending 30th September.	Wool exported. lbs.
1873	42,233,470
1874	47,424,882
1875	49,942,148
1876	55,975,177
1877	56,520,278
1878	62,166,251
1879	62,643,497

The wool produce for 1879 only amounted to 477,246 lbs. more in weight than the produce for 1878. The increase in the wool production has been seriously checked by the increase of rabbits in some parts of the colony.

Mining Accidents in Victoria.—It appears from the report of the Chief Inspector of Mines in Victoria for the year 1880 that the total number of accidents during the year was 134. The proportionate number of persons killed of those employed in and about mines has been 1·31 as compared with 1·29 per thousand in 1879, and 1·93 per thousand in 1874 (the first year in which a "Regulation of Mines Statute" came into operation). The following table shows the number of accidents in the last seven years, as compared with the mining population of the colony during the same period:—

	Miners Employed.	Accidents.	Killed.	Injured.	Total.
1874	46,512	296	90	245	335
1875	42,058	275	83	217	300
1876	41,531	209	55	170	225
1877	38,860	213	64	154	218
1878	37,212	121	40	106	146
1879	37,195	146	48	112	160
1880	38,076	134	50	89	139

Royal Society of Literature.—Mr. Trelawney Saunders will read a paper on Wednesday, July 6th, at 8 p.m., before this society, on "The Recent Survey of Palestine."

	Cwt.	£
*1877	332,304	488,069
1878	421,100	551,856
1879	337,687	434,037
1880	407,451	622,776

† 1861—24th April, No. 2,128; 31st May, No. 2,785; 1st June, No. 2,847; 21st June, No. 3,226; 25th June, No. 3,301; 5th August, Nos. 4,212 and 4,219; 1862—13th February, No. 894; 16th February, No. 983; 24th September, No. 6,096.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, is now open daily. A non-transferable season ticket will be sent to any member of the Society on application to the Secretary. A ticket, to admit two persons, is sent with the present *Journal*.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

WATCHMAKING,

By Edward Rigg, M.A.

Lecture I.—Delivered Monday, Feb. 7, 1881.

Introduction—Units of time—Historical sketch—Description of usual forms of watch—Escapements—Conditions of accurate timekeeping, and arrangements necessary for their maintenance in the higher class of watch.

When I was invited by the Secretary of the Society of Arts to deliver a course of Cantor lectures on Watchmaking, it was with much pleasure, but some diffidence, that I undertook the work. I felt, as any who thought of the matter must have felt, that some prominent member of the trade, who had spent a good many years of his life in that industry, and whose views would therefore be more entitled to the attention of his fellow workers, could with greater propriety have occupied the position in which I find myself; but, at the same time, I am sanguine enough to hope that, in endeavouring to bring the subject before a non-technical audience, it may be possible for me to draw the attention of such watchmakers as may be present, or who may read these lectures, to certain questions that appear to demand further consideration.

It has often seemed to me to be a matter of very great surprise that the public take so little notice of this important mechanical art, an art in which we are all directly interested, and which, in its highest perfection, has long had a home in this country. The true watchmaker has far more to do than to make a piece of jewellery; and in many ways his work possesses even more interest than that of the engineer; by watchmaker, however, I would not here be understood to mean anyone and everyone who chooses to so designate himself, but one who, besides possessing great manual skill, is able to so combine the several parts of the watch, analysing the subtle phenomena that occur, taking cognisance of the minutest mechanical effect, and calculating its proportions, that he may secure the highest excellence in timekeeping; and, added to all this, he must possess an artistic instinct enabling him to impart a graceful appearance to the mechanism. And yet how many there are whose appreciation of the watchmaker's art is limited to a remark on the delicacy of the parts, and the skill of touch and sight that they indicate. A well-finished machine, or even a piece of high-class cutlery, will not unfrequently be more likely to command attention. It may undoubtedly be said that none but those who make it the business of their life to adjust high-class clocks, watches, and chronometers can appreciate the mental labour that has been expended in bringing these instruments to their present state of perfection; but it is hardly less true that, in the estimation of the public, the science and art involved are ignored, and the watchmaker's shop excites no interest except that occasioned by the purely ornamental nature of the objects exhibited.

Let me give you, at the outset, an illustration of the extraordinary degree of accuracy that is now attained in machines for the measurement of time; and I will select one that can hardly fail to bring this point home to you. The chemical balance is a simple scientific instrument that is specially free from the influence of interfering causes, and yet, in its highest perfection, it cannot be made to indicate less than one-millionth of the load in either pan. Thus, with 1,000 grains in each pan, the balance may indicate $\frac{1}{1000}$th grain. It is no uncommon occurrence to meet with a chronometer that does not vary more than $\frac{2}{10}$ths second per 24 hours, or nearly two-millionths of the time measured out, notwithstanding that it is comparatively a complex mechanism, subject to many sources of irregularity, such as variation of temperature, motive force, consistency of oil, &c.

But, although the construction of timekeepers has been brought to such a degree of perfection, and is a question that concerns us all, it has failed to receive the attention it deserves. Its literature in this country is, with one or two notable exceptions, valueless, or nearly so, as a means of interesting non-technical readers. The art has thus been neglected by amateurs, while the trade has for many years been in a somewhat desponding state. But this has not been the case in other countries. France is remarkably rich in horological literature; and the Swiss, regarding watchmaking as a staple industry of their country, have never failed to do all in their power to promote its interests.

We cannot but feel, therefore, that a special consideration of the subject of watchmaking would at this time be particularly opportune in England, and if these three lectures are instrumental in leading to any discussion of the present

condition and future prospects of this most interesting art among us, I shall feel that my labours have been well repaid. While endeavouring to do justice to the exceptional interest which my subject possesses for amateurs and those who are not concerned with it as a commercial pursuit, I shall endeavour, by a comparison of the methods adopted at the several centres of this industry, to ascertain whether changes could, with advantage, be introduced into our system of manufacture, in order to enable England not only to render more secure the position she has so long held, of producing timekeepers unsurpassed by those of any other country, but also to do more than she at present does in the cheaper markets. For it appears that, while the annual total productions of all the other centres of the watch manufacture, in France, Switzerland, Germany, and America, have shown a marked advance, that of England has at best remained stationary—a fact which the statistics of the English watch and clock trades, given in the next lecture, will bring into prominence.

With the exception of turret, regulator, and chime clocks, England has already quite lost the trade in this branch of horology; it retains, however, the first place in the production of high-class watches, and, as regards chronometers, we may still claim to be the foremost producers, for not only are our own naval and mercantile marine supplied, but also to a very great extent those of most other countries.

From the following table, which has been compiled by M. Saunier, it will be seen that in money value England contributes about one-fifteenth of the total production of the world, including all branches of horology, while nine-fifteenths of this total amount is manufactured in France and Switzerland.

Annual Production of Horological Instruments in the World.

France.—Turret clocks, timepieces, watches, and chronometers..	£2,620,000
Switzerland.—Watches	2,400,000
America.—Watches and clocks	1,280,000
Germany.—Clocks	1,000,000
England.—Chronometers, watches	640,000
Austria.—Clocks	400,000

Such a table cannot be more than the very roughest approximation, on account of the difficulty there is in getting reliable statistics, but, if we accept its conclusions, showing as they do that the value of our produce is small in comparison with that of other countries, we must remember that much of the English work bears a very high stamp, and, even if the fabrication of ordinary watches and timepieces is at the present day in great part appropriated by other countries, we yet have a branch of the trade peculiarly our own which well deserves encouragement; and, at the same time, let us not despair of recovering some of the lost ground in cheaper markets. A capacity for seeing the good as well as the bad points in the productions of our neighbours, and a greater willingness to modify our established practice as experience dictates, would greatly help to redeem the character of the cheaper class of English watch.

It may be said that such questions are too technical to interest a general audience, and that they should be discussed and settled by those commercially interested in the art. But this is not altogether the case, and for several reasons. The watchmaker's art has too long been left to take care of itself, the public regarding it as a mystery into which they could not enter, and which could possess little or no interest for them if they did. And yet they often take care to dictate conditions more or less unreasonable, because they are prejudicial to the advance of the art; and the fashion of wearing very thin and very small watches prevailed for long periods without the slightest regard to the fact that such conditions are fatal to good time-keeping. The absence of literature is, doubtless, to some extent, responsible for this state of things, but, neglected though it has been, I hope to be able to show, in the course of these lectures, that our English watch trade, while well worthy of attention on account of what has been done in the past, also urgently requires it with a view to improving its prospects in the future. And in order that I might speak of the subject to some extent from actual experience, I have visited several centres of the industry in this country, Coventry, Prescot, and Birmingham, being acquainted already with the work of Clerkenwell; and I would take this early opportunity of thanking very sincerely all those members of the trade who have enabled me, often at no little inconvenience to themselves, to see many of the numerous operations that are involved in the production of a watch. I shall more particularly specify those to whom I am thus indebted in the second lecture, when explaining the systems of manufacture.

Before proceeding to consider briefly the various stages through which timekeepers have passed in arriving at their present state of perfection, it may be well to ask, What is time? This question is more easily asked than answered. For we cannot picture to ourselves what time itself is. We can only appreciate an interval of time as the period between two events, and if we have sufficient evidence to show that the period between two events, A and B, is neither more nor less than the period between two other events, C and D, we say that the intervals of time are equal. But such a statement rests on the supposition that the evidence is sufficient, and the division of time must ultimately rest on a supposition, doubtless highly probable, but still not certain, since we are not so organised as to be able to test it, that the period of recurrence of a definite phenomenon is invariable.

It is, then, well to remember that although all our arrangements for the measurement of time can be justified, they do rest on a supposition which is entirely beyond our powers to either prove or disprove. If the above assumption, however, be granted, we at once have a means of testing the time-keeping properties of our clocks and watches, and no further supposition need be made.

From this point of view, a watch or clock is not an instrument for causing an index to travel at a uniform rate, but rather an arrangement for conveniently counting up equal short periods of time, *i.e.*, the periods represented by oscillations of the balance or pendulum.

It should be observed that the length of the period of time that is taken as a unit of

measurement varies according to circumstances, just as the unit of weight is a grain, ounce, pound, or ton, according to the value or bulk of the object for whose weight an expression is required. Geologists take thousands of years as a unit, since that is comparable with the periods assumed to have elapsed between successive important events in the formation of the earth's crust. Physicists, on the other hand, often deal with very minute fractions of a second. Thus, light is known to travel at a rate of about 196,000 miles per second, and yet it was found possible to calculate this velocity from so short a period as thirty millionths of a second, the time required to travel over a distance of not more than six miles. In the ordinary transactions of life, a minute, hour, day, or even week, may be considered as a unit, according to circumstances; and it is a marked characteristic of modern life that the tendency is towards the adoption of the shorter intervals as units.

Everyone knows that a day is the interval that elapses between two successive risings or settings of the sun, and an hour is understood to be 1-24th of this interval, while the minute and second are respectively $\frac{1}{60}$th and $\frac{1}{3600}$th of an hour. But it is worth while pointing out that the measurement of time is not so simple as would appear from such a statement. Let it be granted that each revolution of the earth is performed in the same interval of time. A day is defined as the period that elapses between the departure of any meridian from a heavenly body and its succeeding return to it, as observed by the aid of a transit instrument; and, if the earth were the sole moving body in the universe, transit observations made on all the heavenly bodies would prove these intervals to be in all cases the same. The stars may, for all practical purposes, be regarded as stationary; and thus, if the earth's revolutions be determined by observations made on any given star, all days will be of equal length; the sun, moon, and planets are, however, also in continual motion, with velocities not only different from each other, but varying in each particular body. The length of a day, then, as determined by any of these bodies, must necessarily be a variable quantity. To take the case of a solar day. Our earth rotates from west to east, performing each revolution in a constant period; but its motion round the sun, that is, in the ecliptic, is such that the sun appears to be revolving round it, also from west to east, but with a much less velocity; any given point on the earth's surface has to perform more than a complete revolution before its meridian can, so to speak, catch up the sun, and the solar day will be longer than the period occupied by a revolution of the earth by a corresponding amount. The case is, roughly speaking, analogous to that of two successive coincidences of the hour and minute hands of a watch. Assume that the hour hand indicates the sun, and the minute hand a point on the earth's surface, and that they are together at noon. The minute hand at once advances on the hour hand, and, if this remained stationary, would again coincide with it in 60 minutes; but, in the meanwhile, the hour hand has advanced through a space of five minutes, and thus, to an observer supposed to live at the extremity of the minute hand, the "solar day" would be rather more than 65 minutes, although a complete revolution was performed in 60 minutes. Owing to various causes, however, into which we cannot now enter, the difference in the case of the sun is a variable quantity; it can be determined by the aid of tables of the equation of time.

The day of 24 hours is the mean or average of all the apparent solar days in a year. It does not represent the time occupied by the earth in performing a revolution on its axis, a period which, observed from a distant fixed star, would be found to be 23 h. 56 min. 4·09 sec. of mean solar time; and, although an arbitrary division of time, it has important advantages, because clocks cannot be made conveniently to go with the sun, but can be arranged to go uniformly. It is thus seen that we have three kinds of day to measure. A true or apparent solar day is the period between two successive coincidences of the sun with the meridian of any given place. It is the interval between two successive noons on a sundial, but cannot be recorded by an ordinary clock since the days are unequal. A mean solar or civil day is the average of all the true solar days in a year, and corresponds to Greenwich mean time, or what is often termed "railway" time. Lastly, a sidereal day is the period occupied by each revolution of the earth, or, as already explained, 23 h. 56 min. 4·09 sec. of mean solar time. All sidereal days are of equal length, and thus, if a watch or clock be set to gain 3 min. 55·91 sec. per day on Greenwich mean time, it will indicate sidereal time, assuming, of course, that it be in the first instance set with a standard sidereal clock.

Although my principal object is to consider the systems of manufacture of watches, there are other points of view from which the measurement of time possesses much interest, not the least important of these being the historical. I propose, therefore, at the outset, to briefly enumerate the several stages time measurers have passed through, especially referring to those of a portable character. The natural divisions of time, which cannot have escaped observation in the remotest antiquity, are such as the rising and setting of the sun, and the phases of the moon. But there is very great uncertainty as to the earliest means in use for the measurement of time. Certain French writers assert that the obelisks were originally set up as a means of indicating the time by the sun's shadow, a view which seems to derive some support from the term "finger of the sun," applied to them by the Egyptian priests. On the other hand, their position at the entrances to temples, &c., seem to render this view doubtful. The first obelisk is said to have been set up B.C. 1485.

The sundial may have been the result of a gradual improvement in some such form of time indicator, but the evidence as to the precise date of its invention is far from definite. The text in the Book of Kings, referring to the "dial of Ahaz," who reigned about 730 B.C., cannot be accepted as conclusive evidence of their use at that period, as the word translated "dial," is the same as is rendered "degrees," in the same verse. Some authorities assign the discovery to Anaximander (B.C. 610—547), the reputed inventor of maps; but, after all, the question turns on the definition of a sundial, for the Egyptian obelisks would

suffice to determine mid-day and, in a sense, to subdivide the day. The essential feature of a sundial is a style fixed parallel to the axis of the earth; its inclination will, therefore, gradually increase as we move from the equator, where it lies horizontal, to the poles, where it is vertical. The shadow of this style is cast on to a graduated circle.

The first time-measurer, whose action did not depend on astronomical phenomena, was the clepsydra or water-clock, an instrument which, probably existing in a simple form much earlier, was brought to a high state of development by Ctesibius, about B.C. 250. In its primary form it doubtless consisted of two vessels, one of which, containing water, was fixed above the other, and into this latter the liquid gradually escaped, indicating the time by the rise of its level. It is curious to note that the Brahmins of the present day are stated to employ a similar system for the measurement of periods of time. A copper vessel perforated with a small hole is floated on water, and immediately on its becoming full the attendant empties it, and strikes the hour of the day or night. But the problem of adapting the clepsydra to indicate the time was one of considerable complexity. For it must be remembered that the day and night were each divided into twelve hours, these hours therefore differed between themselves, and varied from day to day. The ingenuity displayed in the construction of these machines is truly wonderful; some of them automatically adjusted for this variation in the day's length, while in others the adjustment required to be made by hand. Anyone interested in their construction will find several forms illustrated and described in Rees's "Cyclopædia," article "Clepsydra."

If we may credit the accounts that have been handed down to us, some remarkably complicated mechanisms, based on the water-clock, and giving all the movements of the heavenly bodies, signs of the zodiac, &c., as well as indicating the time, were invented before the next great advance in horology, the introduction of a weight motor ten or twelve centuries later. I will only add that the principle of the clepsydra is still of very great value to the physical experimentalist where brief and irregular intervals of time require to be measured with accuracy. With a properly arranged apparatus, it is only necessary for him, by depressing a handle, to start the flow of water, and to release the handle immediately on the completion of the observation. The weight of water thus allowed to escape affords a means of measuring the time elapsed.

The sand-glass, or clepsammium, was probably discovered subsequently to the water-clock, and authorities differ very much as to the date of its first introduction. It is, perhaps, safe to assume that this was at some period during the first three centuries of the Christian era.

Water appears to have afforded the sole motive power for clocks till towards the close of the tenth century, when the celebrated Pope Sylvester II. is generally credited with having constructed a clock for Magdeburg, which was driven by a weight. Professor Hamberger, however, in a paper read in the year 1758, and published by Beckmann,* doubts his title to the discovery, pointing out that no mention is made in the original account by Dithmar, of either wheels or weights. He considers the invention to have more probably consisted of a sundial, and substitutes William, Abbot of Hirschau, in the eleventh century, as having introduced a timekeeper which was, at all events, neither a sundial nor a water-clock; and in a subsequent part of his paper he suggests that the Saracens, "to whom we are indebted for most of the mathematical sciences," were in all probability inventors of clocks moved by wheels and weights.

But the references to horology in the writings of this early period are exceedingly meagre, and we have no precise evidence of the use of weights controlled by what is now termed an escapement, until the 14th century, when the verge, or "folliot" escapement, one form of which is shown in Fig. 1,

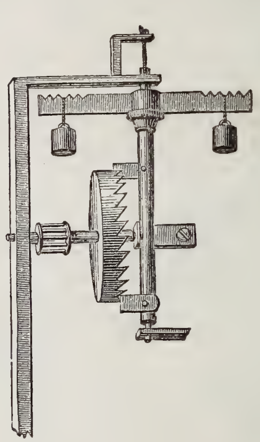

Fig. 1.

came into use. The mode of action of this will be explained when we come to consider escapements generally.

It is impossible to believe that no progress was made during these four hundred years, and that a single inventor is entitled to the entire credit of the discovery of the new clocks. Nor can we definitely say who it was that first introduced them; for about the same time, early in the fourteenth century, there lived, in England, Richard of Wallingford, Abbot of St. Albans (which abbey, by a curious coincidence, is now being restored, mainly at the expense of Sir E. Beckett, one of our most prominent living horologists); in Italy, Jacques de Dodis, doctor and astronomer of Padua; and, in Germany, Henry de Vic, all of whom became famous as clockmakers.

The next important horological advance seems to have been made by Peter Hele, a clockmaker of Nuremberg, who, in the early part of the sixteenth century, succeeded in overcoming the principal difficulty in the way of a portable timekeeper, the fact that the motive power was obtained from a descending weight; this he replaced by a coiled steel spring. In the early watches, which obtained the name of "Nuremberg eggs," the verge escapement, similar to that already in use for clocks, was employed. The balance, in some cases only a straight bar with weights at either end, represented in Fig. 2, was not provided with a balance-spring, for the verge escapement differs

* "History of Inventions," vol. 1., p. 340. 4th Edition. 1846.

from most others in being capable of performing its functions as a controller of the mechanism, though very imperfectly, without this addition.

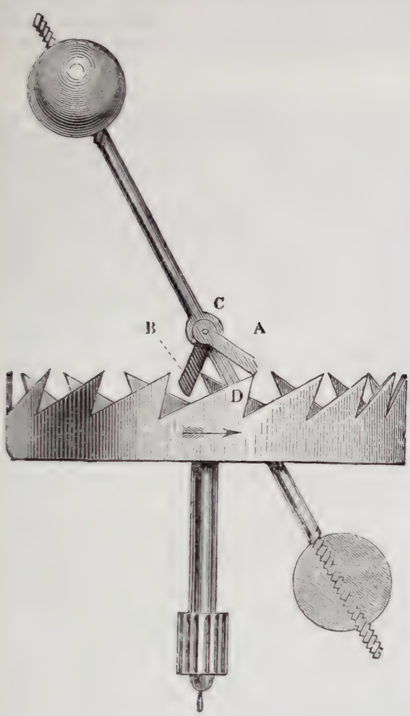

Fig. 2.

In these early watches, a peculiar device, known as the *stackfreed*, seems to have been first used for obtaining a greater degree of uniformity in the motive force. No description of this arrangement has been handed down to us, but I have made this drawing (Fig. 3), based on a brief account given by Octavius Morgan, Esq.* It will at least afford a suggestion as to the manner in which the stackfreed may have worked. As a spring is gradually coiled up in a barrel, the force tending to cause rotation increases, and the watch will gain. The outer end of the mainspring being fixed, the inner end is fixed to an arbor that carries the wheel A, of 8 teeth, which engages with the wheel B, of 24 teeth, one space (D) of this wheel being left uncut to act as a stop. As the arbor of A makes three complete rotations in a day, B will turn once in the same period. On its axis is fixed a cam of some such form as C, against which a powerful spring presses. Assume that, in unwinding, A rotates in the direction of the hands of a watch. The force opposed by the spring pressing on C to the motion of B will gradually diminish as it rotates. When the spring is about half down, a period is reached during which the opposing force remains constant, and afterwards, while pressing against the concave face of the cam, it supplements the force of the mainspring to a gradually increasing extent. Thus the tendency is to secure an approximate uniformity in the motive force.

The inventor of the fusee, and the date of its first use in a watch in place of the stackfreed, are alike unknown; but a very remarkable clock in the possession of the Society of Antiquaries,*

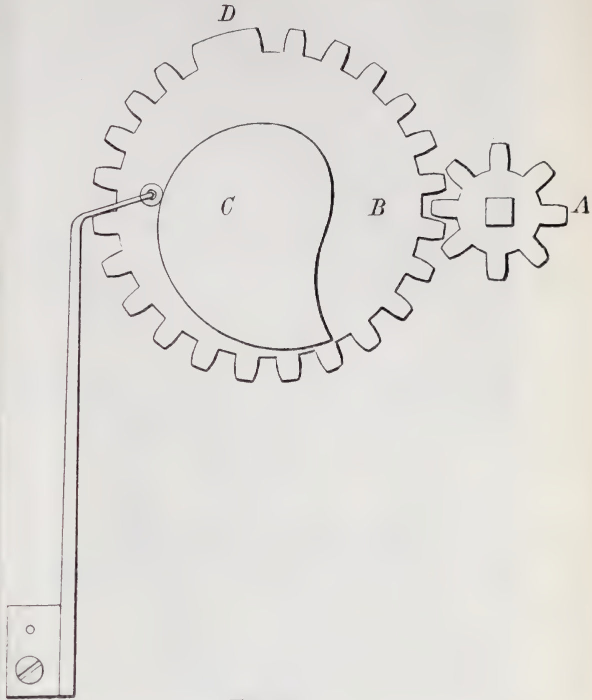

Fig. 3.

seems to afford authentic evidence of its having been employed for clocks as early as 1525. The timepiece in question, bears the name of Jacob Zech, of Prague.

It is worthy of note that, up to this period, timekeepers appear to have been employed for civil purposes and in monasteries, not as astronomical instruments; but it now began to be felt that they could render important aid in that branch of science. The credit of having first used a clock in the observatory, is claimed for Walther, of Nuremberg, towards the end of the fifteenth century; and in 1530, very shortly before the announcement of Hele's discovery, G. Frisius, a Dutch astronomer, suggested, that longitude might be determined at sea by the aid of portable clocks, thus opening up a question which, more than any other, has stimulated the progress of horology.

Galileo, about 1639, made the next great advance when he published his treatise on the properties of the pendulum, discovered, probably, towards the close of the previous century. But he did not actually apply it to a clock, although he is asserted to have dictated to his son Vincent, after being struck with blindness, the description of a pendulum clock; the honour of this application is claimed by Huyghens, V. Galileo, and Hooke.

I cannot pretend to discuss their respective claims; suffice it to say that to Huyghens, whose

* "Archæologia" (1849), vol. xxxiii., p. 295.

* "Archæologia" (1849), vol. xxxiii., p. 8.

profound knowledge and ingenuity raised horology from being a purely empirical art into the position of a science, is almost universally awarded the credit of this invention. Although the substitution of the pendulum for the old form of balance, had immeasurably improved the timekeeping properties of the clock, Huyghens, finding that the vibrations of a pendulum are not rigorously isochronal, or performed in equal times when of varying extent, endeavoured by the aid of geometry to further increase its accuracy, and was thus led to the discovery that if a pendulum be caused to perform a cycloidal instead of a circular path the vibrations will always occupy equal intervals of time. This profound research into the properties of the pendulum was mainly prompted by an ambition to employ the clock for determining longitudes at sea, in accordance with the suggestion of Frisius, nearly a century and a half previously; and Fig. 4

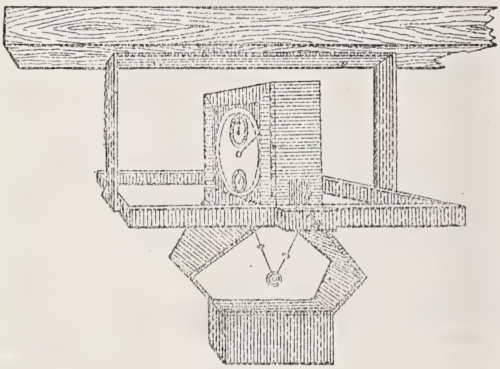

Fig. 4.

is very interesting as representing a form of clock, supported in gimbals, and maintained steady by a heavy weight below, which Huyghens proposed for that purpose. Robert Hooke, however, assures us that Lord Kincardine had, a few years previously, experimented on a similar form of clock; and the very first number of the "Philosophical Transactions" of the Royal Society, published in March, 1665, contains a note, describing the successful employment of these "pendulum watches" by Major Holmes, on a voyage from Guinea to the "Isle of Fuego."

Huyghens was led, by his investigations, to the discovery of a fact of infinite importance in the exact measurement of time, the fact that when a pendulum oscillates through very short arcs, their periods are isochronal within the limits of observation. The verge escapement, however, the only one in use at the time, required a vibration of considerable extent, so that the great geometer was precluded from taking advantage of his discovery, which follows directly from his law of the cycloidal path, since, for short arcs, the circular and cycloidal paths are practically coincident.

It was about this time (1660) that the discovery of the balance-spring, by which portable timekeepers indicating the time with any degree of accuracy were, for the first time, rendered possible, was announced by Dr. Robert Hooke; and his invention was very soon claimed by Huyghens and Hautefeuille. Although authorities generally concur in admitting the Englishman's title to having first applied a spring to the balance, Huyghens seems to have first employed, in 1674, a spiral steel spring, such as is in universal use at the present day. This well-known arrangement is shown in Fig. 5, from which it will be seen that the inner

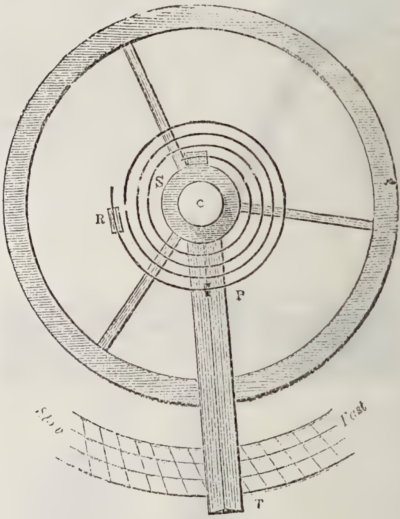

Fig. 5.

end of the spring is attached to the balance at S. R is a stud fixed in the balance-cock, in which the outer end is fastened; and, at P, the outer coil passes between two pins in the index, or regulator, T.

The adaptation of the pendulum to clocks, and the application of a steel spring to the balance, gave a stimulus towards some improvement on the folliot or verge escapement, the only one in use for either clocks or watches. So long as it continued in use, Huyghens was compelled to secure cycloidal vibrations in clocks, since relatively long arcs of vibration were essential. This he did by applying the cycloidal cheeks to the upper end of the pendulum rod, in the manner shown in Fig. 6. If the

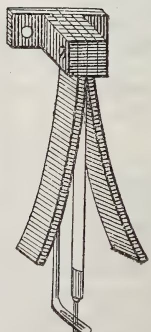

Fig. 6.

two shaded pieces are in the form of a cycloid, and the pendulum is suspended by two parallel silk threads, which alternately wrap over these cheeks,

it may be proved that the path of the bob will also be a cycloid. In 1680, Clement, a London clock-maker, made a great step in advance by introducing his (recoil) anchor escapement, with which shorter, and therefore more nearly isochronal arcs of vibration, were possible. The form of the pallets was changed to that shown in Fig. 7, so as

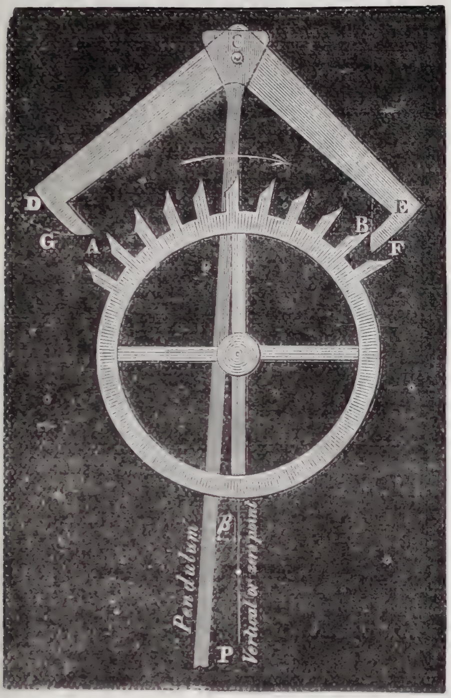

FIG. 7.

to give a dead-beat instead of a recoil escapement, about thirty years later, by G. Graham, a man who has done more than any other Englishman to promote the art of horology. His more important inventions, the cylinder and dead-beat anchor escapements, and the mercurial pendulum, are highly esteemed at the present day; the well-known gridiron pendulum was also first suggested by him, although carried out by Harrison. Indeed, it is reasonable to assume that his improvements in the anchor escapement led to the last two inventions, since the rates of clocks had not previously been sufficiently good to render variations caused by changes of temperature of any moment. Other escapements and other methods of compensation have of course been invented since Graham's day, and the details of workmanship have improved, but he is unquestionably entitled to the credit of having first made an astronomical regulator possible, and the comparative unimportance of the few changes introduced during the 160 years that have elapsed bears indisputable testimony to this fact.

These improvements in stationary clocks were very soon followed by important advances in portable timekeepers, with a view to the determination of longitude at sea; an operation which essentially depends on the exact coincidence of two timekeepers that are separated from one another. This is obviously a problem possessing the highest commercial importance, and the labours devoted to the perfection of marine chronometers have, at the same time, given us all the greatest improvements in pocket watches. The interest excited by the question can hardly be appreciated at the present day, when every ship carries one or more chronometers as a matter of course; all the maritime Governments offered rewards for its solution, and our own Parliament, on the recommendation of a committee of which the immortal Newton was a member, voted in 1714 a sum of £20,000 to the inventor of a marine timepiece that should not vary more than two minutes in 42 days, thus giving the longitude to within half a degree at the end of that period.

Henry Sully, an Englishman living in France, was one of the first to take the problem seriously in hand, and in 1723 he completed a clock for use at sea. It can hardly be taken as a proof of any radical advance in the art, and, considering how highly esteemed its inventor was as a horologist, we may be surprised that he should have designed such an instrument. Moinet assigns as a reason for giving a somewhat detailed description, that it will "serve as an illustration of the errors into which a man of ability and some experience may fall." A heavy circular balance is supported by a horizontal axis on anti-friction bearings. This axis also carries a radial pair of curved cheeks, and an index, the whole being in equipoise. The escapement by which the impulse is communicated partakes of both the verge and lever forms. A cord attached to the balance-staff, and passing alternately over the two cheeks, is connected with a circular arc forming part of a horizontal lever, also on anti-friction bearings, with which this arc is concentric. While the lever is raised by the action of the escapement, its descent gives an impulse to the balance; the action of the weighted lever, then, corresponds to that of a balance-spring. It is useless to point out the objections to such an arrangement, which, after all, only involves the use of a pendulum in disguise; the friction throughout the escapement was excessive, and the instrument was not independent of position or latitude. He seems to have gone out of his way to avoid using the balance-spring, then well known, and failed to see how essential it was to entirely change the escapement itself. This most important investigation was taken in hand by his immediate successors, Harrison and P. Le Roy, the inventors of a special remontoire and of detached escapements respectively, and the former secured the award of the English Government in 1767. In a remontoire escapement the motive force, instead of acting directly on the balance, is employed to raise a weight or spring which, in turn, impels the balance, the object in view being to secure a strictly uniform motive force. But horologists now generally admit that in a watch or chronometer such a precaution is entirely unnecessary, and it was Le Roy's great discovery, first announced in 1748, that led the way to the final solution of the problem, the chronometer escapement of the present day. I shall presently have occasion to refer to the principle of detachment which he introduced, and would here only explain that it consists in releas-

ing the balance from its connection with the other parts of the escapement during the greater part of its motion.

Portable timekeepers had now reached such a degree of perfection that their rates were appreciably affected not only by variations of temperature, but also by the want of isochronism when the arcs of vibration were of varying extent. Harrison's elegant mode of counteracting the first of these interfering causes by a bimetallic strip applied in various ways was only equalled by that most beautiful discovery of Le Roy's—the isochronal balance-spring; they were both essential to the perfecting of the marine chronometer, and it appears we can no more dispense with the practical suggestions of the one inventor, than with the more theoretical discovery of the other.

Many great horologists have lived since the days of these men, but they have worked mainly on the lines indicated by them. It would be travelling beyond the limits of a general historical sketch to refer to the special work of Arnold, Earnshaw, Berthoud, Breguet, and others, in the endeavour to improve the marine chronometer. We are mainly concerned with the pocket watch, and it is noticeable that, prior to 1760, attention seems to have been directed towards increasing the complexity rather than the timekeeping properties of the instrument. Thus the invention of repeaters took place immediately after that of the balance-spring, namely in 1676 and Johannes Coccleus states that Hele even made a "striking watch" early in the sixteenth century; indeed, throughout that century, striking, alarum, and calendar watches seem to have been not uncommon.

The verge or "pallet" escapement was the only one in use for watches until 1700, when Graham perfected his cylinder escapement, based on a suggestion of his master, Tompion. This form, though unsuited to the chronometer, has been used more than any other in watches, for reasons that will be evident when we consider it more in detail. It cannot be doubted, that many efforts were made to adapt to watches the dead-beat escapement, which had proved to be of so much value in clocks, but an important difficulty lay in the fact, that, while this form of escapement requires only a short arc of oscillation of the pallets, the regularity in the rate of a balance is materially impaired if the extent of its arc of vibration is reduced. It was essential then to so co-ordinate the balance and pallets, that these two conditions were satisfied. The Abbé Hautefeuille invented an escapement as early as 1722, which satisfied them, but fresh sources of error were introduced. It is known as the rack lever, and shown in Fig. 8. The balance, C D, and escape-wheel, A, are concentric, but on independent axes. On the balance-staff is a pinion, F, which engages with the segmental rack, E, at one end of a poised lever, E G; to this are fixed the pallets, B, as in the modern lever watch. Indeed, this is the forerunner of our modern escapement, from which, however, it differs in one essential particular. The balance is never liberated from the lever. This very important modification was introduced about 50 years subsequently by Thomas Mudge, a well-known English maker, in a watch he made for Queen Charlotte. His own account of the invention shows that his escapement closely resembled the "right-line lever" very frequently met with in Geneva watches; the value of this

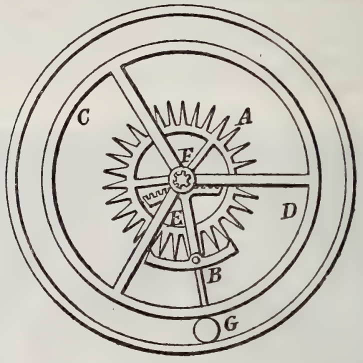

Fig. 8.*

discovery of Mudge's consists in the fact that during the greater part of its vibration the balance is detached or free to move out of contact with the other portion of the mechanism.

One other radical change in the pocket watch remains to be mentioned. A few years after Mudge effected this improvement (1766), the celebrated Lépine, associated with Voltaire in the manufactory at Ferney, introduced his important modifications in the arrangement of a watch—changes which have been maintained until the present day on the Continent, in all but the cheapest manufactures. He suppressed the fusee and chain, the pillar-plate, and one pivot-hole of the barrel arbor, one plate only being used, and the top pivots fixed by separate cocks. The fusee was thus replaced by the barrel, which, being provided with teeth, communicated its motion direct to the minute-hand axis, and became known as the "going barrel." [These changes were made clear by the aid of a large diagram and a model, showing all the parts of a watch, kindly lent by Sir John Bennett.]

We have now very briefly traced the history of horology from the earliest times to the immediate originators of the clocks, chronometers, and watches in use at the present day. We see that while the escapement used for most of our best clocks, Graham's dead-beat, was invented as early as 1700, the commencement of the present century found the modern lever and chronometer escapements already the subject of investigation, and the patient experimental determination of the most suitable proportions, and of various details of construction, of these as well as of the horizontal escapement, has mainly occupied horologists since that period. The principal errors to which a clock is subject had been overcome by Graham himself; Harrison and many who succeeded him endeavoured to avoid irregularities in the rate, owing to want of isochronism, by a constant force or remontoire escapement, relying on this absolute uniformity in the motive power giving an arc of vibration of invariable extent; Le Roy's beautiful investigation into the action of the balance-spring proved, however, that the true solution of this problem lay in the fact that there is a length of

* This block, taken from Nelthropp's "Treatise on Watch-work," is kindly lent by Messrs. Spon. Figs. 2, 5, and 7, are from Sir E. Beckett's "Clocks, Watches, and Bells," 1874 (Crosby Lockwood and Co.).

any given spring, providing it is well made, which causes vibrations of varying extent to be performed in equal times, just as, with the pendulum, there is a path, the cycloid, that alone secures perfect isochronism. That other principal source of irregularity in clocks—variation of temperature —affects portable timekeepers to a still greater degree, and although more inventive power has been expended on the question of compensation than on any other, it is still but partially solved; indeed, it is well worthy of note, as illustrating at once the remarkable progress made by the earlier horologists and the very slight advance made since their day, that the compensation balance, shown in Fig. 9, which is now often used in

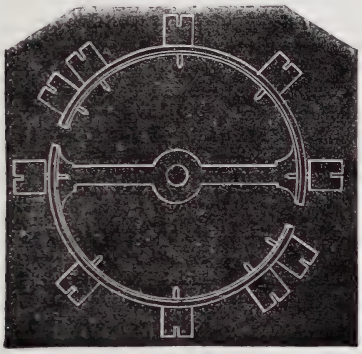

FIG. 9.

chronometers and always used in the best watches, differs in no respect from those employed by Arnold and Earnshaw at the latter end of the eighteenth and beginning of the present centuries. Arnold, as early as 1775, took out a patent for the cylindrical or helical balance-spring still used in chronometers, and, nine years after, Breguet invented his flat balance-spring with overcoil, which is now esteemed the best for watches.

(*To be Continued.*)

DOMESTIC ECONOMY CONGRESS.

(*Report continued from p. 641.*)

The meeting of Thursday, 23rd June, was held at the Royal Albert Hall, at 11 a.m.; Mrs. DACRE CRAVEN in the chair, and Dr. MANN, F.R.C.S., Assessor.

SECTION C.—THE DWELLING: WARMING, CLEANING, AND VENTILATION.

Dr. Mann called attention to the fact that the meeting was presided over by a lady, the Assessor simply acting as her assistant, and desired that all remarks, therefore, should be addressed to her.

Mrs. Dacre Craven read a paper on "Warming, Cleaning, and Ventilation of Schools and Dwellings in London and large Towns, from a Nurse's Point of View."

Mrs. Dacre Craven, in answer to the question how ladies could best acquire the practical knowledge advocated, said that nurses for the sick poor were trained at Bloomsbury-square, and they might teach in various parishes.

A Lady suggested that the St. John's Ambulance Organisation might be made useful for this purpose.

Sir Henry Cole asked what age Mrs. Dacre Craven would recommend should be fixed as the earliest for the teaching she recommended? He desired to emphasise the point that a commencement could not be made too early, and should certainly be made in the infant school. With respect to the defects in good houses as well as bad, both in London and the country, even in Birmingham, where the people lived under an efficient and watchful municipal despotism, he found in a house he was going to occupy there a stream of sewer gas flowing into the cellar, and that the water was not potable. He found all the defects that could well exist in a house, and had saved his health by taking care to get them remedied at once by making complaint in the proper quarters.

Rev. Dacre Craven said that in old-fashioned houses windows were not constructed to open at the top. In his own house in London, built a hundred years ago, not one of the windows had been so made, and he had had to remedy that defect. Many people really did not seem to understand that opening windows in that way was a necessity for letting out foul air, and often their only chance of getting proper ventilation was when a window happened to be broken. Most simple means could be used for the purpose if people would only adopt them, as it was an easy thing to leave a window open for a small space at the top and to hold it up at the bottom, even in the absence of proper sashes, by the insertion of a piece of stick.

Mrs. Talbot said she had found the advantage of recommending, in latticed windows of small houses, the knocking out one or two of the small lattice panes.

Sir Henry Cole said there was a general and profound ignorance on the subject of ventilation, and even where in schools the necessary arrangements were made for obtaining it, the students would manage to get rid of them if they possibly could. Women, he thought, would be much better advocates and inspectors in these matters among poor people than men.

Miss Kenrick said there was no difficulty at all in making children, in the 4th, 5th, and 6th standards, thoroughly understand what was best to be done, in cases of sickness, scarlet fever, changing linen, and so on. They gave their mothers the benefit of the instruction they had received, and by following what their children were able to tell them the parents were often successful in preventing the spread of disease.

Frau Morgenstein offered a few remarks in German, giving her experience of her schools of cookery in Berlin, where 10,000 workpeople were daily fed. She had also interested herself in taking females direct from prison, and by educating them in these matters, enabling them to become respectable members of society.

Mrs. Dacre Craven said Frau Morgenstein's remarks would have more application in the cookery section.

Dr. Mann said that the great objection to open windows on the score of draught, might be obviated by the use of copper wire gauze, hooks, and a few simple appliances.

Mrs. Dacre Craven suggested that the foul air from sinks and dust-bins might still enter, and that care must be taken to prevent any danger from that source.

Lady Stuart Hogg thought poor people might find difficulty in providing themselves with the copper gauze and other things recommended.

Dr. Mann said difficulties would soon disappear when people were once made to understand what was required to be done.

Paper by Miss Pilkington, on "The Walton School Laundry," was read by **Miss Webb.**

Miss Guthrie Wright recapitulated from a small hand-book she had written, directions for washing as given at the Edinburgh School of Domestic Economy.

Sir Henry Cole referred to an order promulgated as long ago as 1857 by Mr. (now Sir R. R. W.) Lingen, Secretary of the Treasury, with regard to the establishment of laundries, and remarked that a miserable decadence had taken place since that time. He was unable to say whether laundries did exist in all the female training colleges, but from some cause or other it was found that where established it was cheaper to give out the washing than that it should be done by the students themselves.

Miss Harriett Martin's paper, "Washing-day in Cottages and Small Dwellings; Some Hints upon the Method of Teaching Washing," was read by **Dr. Mann.**

Rev. Dacre Craven said few houses in London possessed means of obtaining soft water. Teachers would be very willing to instruct girls how to wash by practical demonstration, but proper washhouses should be provided for the purpose, for it would be impossible for much good to be done with a board and a piece of calico; and the schoolmistress of the present day might not care to give practical instruction at the washing-tub. Still, that was the only way in which it could be done properly.

Sir Henry Cole thought the practical teaching might be given in public laundries if established. Such laundries might be organised in connection with the Board schools, and thus utilised for teaching purposes.

Mrs. Talbot considered that any School Board which proposed to take the ratepayers' money for building a laundry would raise a storm of opposition.

Sir Henry Cole was not proposing that that should be done, but that the parochial powers should establish baths and washhouses, and co-operate with the School Board for their use for teaching purposes. He was glad to find that in Bermondsey and some other parishes in London buildings of that description had been erected, and the matter was one which merely required a little organisation.

Miss Guthrie Wright thought that poor children in schools were already over-burdened by teaching, and she thought laundry work should not be added. The difficulty might be solved by the adoption of the continental plan of establishing technical schools, to which girls might go after leaving the elementary schools. Such establishments might work either under the Board or in connection with our public schools, such as that for domestic economy, and there the girls might go through a three or six months' course of teaching in laundry work, dressmaking, or other subjects, which would enable them to find better occupation in after-life. By such a plan as that, the difficulty of teaching children domestic economy in schools would be avoided.

Sir Henry Cole urged that in some respects the Education Code was too exacting upon young children, in subjects which could be of no great use to them in comparison with the teaching of domestic economy subjects. Poetry, algebra, Euclid, French, and German, were some of the matters he alluded to.

Mrs. Talbot said that part of the Code applied to boys, and they could not be taught more than two of those subjects.

Sir Henry Cole said that was two too many. Teaching the children such knowledge was really time and labour thrown away.

Mrs. Talbot added that extra subjects could not be imposed upon the girls until they had been taught domestic economy. It was an advantage to girls and boys alike to learn to understand good cooking.

Sir Henry Cole's argument was, that children were pressed too heavily by the Code, which demanded reading, writing, arithmetic, and grammar from the infants in Standard I. Standard II. required from children of eight, among other matters, notation and numeration up to 100,000, and they had much better learn something about washing. A child was never too young to be taught the simple principles of domestic economy.

Mrs. Dacre Craven said it was a fair question whether some of the subjects imposed by the Code might not be left out in favour of others which would be directly useful.

Mrs. Talbot objected that teachers had already quite enough to do; and said they would never be able to teach washing in addition. Public washhouses were not so eagerly sought after by poor people as seemed to be considered; and in her own town, an establishment of the kind had been shut up, because the women would not go out in public and expose the state of their clothing to their neighbours. In London, however, they might accept the alternative to washing in the one room occupied by the family.

Mrs. Dacre Craven hoped that in another generation the poor would have better houses to live in, and better accommodation.

Mrs. Tulloch believed it would be a mistake to introduce washing as part of the school education. No little child should be put to stand over a wash-tub with heavy clothing to manipulate, as the age of 13 was quite early enough for that. It was really not a matter for school education at all.

Mrs. Dacre Craven remarked that, unfortunately, poor children were taken away from school before they were 13, as they were too useful at home to be allowed to stay. She had herself learned to wash at the schools in Germany, and could testify to the great labour it involved.

Dr. Mann pointed out that to some extent ladies were wandering from the question before them, viz., whether some easy and simple means might not be found for teaching children the methods or first principles of washing by, if necessary, a little alleviation of other subjects of instruction.

A Lady offered, on behalf of Frau Morgenstein, a paper on the subject of teaching washing.

Mrs. Dacre Craven said it would be gladly accepted. She had understood that lady's previous remarks to be rather outside the subject, referring as they did to the manner in which poor people were fed in Berlin, and not to washing, cleaning, and ventilation.

Mr. E. A. Hadley's paper, on "Pure Air and Cleanliness, the True Basis of Health and Comfort within the Reach of All," was read by **Rev. Dacre Craven.**

Capt. Douglas Galton, C.B., F.R.S., read a paper on "The Maintenance of Pure Air in Dwellings."

Dr. Mann expressed the indebtedness of the Congress to Captain Galton for his valuable paper, for which they ought to be doubly grateful, as he had prepared it by special request.

Mrs. Dacre Craven asked whether Captain Galton would recommend the placing of dust and refuse outside houses for daily removal.

Capt. Galton was in favour of that course if a proper covered receptacle were used.

Mrs. Dacre Craven said the remuneration demanded by dustmen was an obstacle to their employment, and poor people often let their dust and refuse accumulate for two or three months. Unless some law could be passed on the subject of the removal of such sources of nuisance, very little could be done to remedy the existing state of things in that respect. The air surrounding poor houses was so vitiated by emanations from the dust-bins, that they could not even obtain fresh air by opening their windows.

The meeting then adjourned for a repetition of Mrs. Buckton's lecture at four o'clock, by express desire of H.R.H. Princess Christian.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday last, the 11th inst., at their first meeting, the Council elected Frederick J. Bramwell, V.P.Inst.C.E., F.R.S., as Chairman for the ensuing year. The various committees were also re-appointed.

EXAMINATIONS, 1881.

The list of successful Candidates in the Examinations for the present year has been printed, and is forwarded to the Institutions in Union with the present number of the *Journal*. Copies will also be sent to the various Local Boards for the successful candidates.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

WATCHMAKING,

By Edward Rigg, M.A.

Lecture I.—*Continued.*

The barrenness of the last hundred years in horological invention is in striking contrast to the wealth of the century which preceded it. In 1680, the balance-spring was but recently invented, Graham and Sully were just born, Huyghens and Hooke were still in the prime of life. In 1780, we already possessed the dead-beat clock escapement and various compensation pendulums, Arnold's modifications of the chronometer escapement, isochronal balance-springs, compensation balances, the lever and cylinder escapements, in fact, all the broad outlines of our timekeepers of the present day. If we desire to see what progress has been made since that date, we can only seek it in a more just proportioning of the several parts, an increased production, a more exact workmanship, and a more scientific knowledge of the laws by which timekeepers are governed. With but few exceptions, the improvements effected in the timekeeping properties of watches have not resulted from investigations made with that object in view, but as a necessary consequence of their resemblance to the chronometer.

One fact, however, in partial explanation of this absence of change, suggests itself. Amongst the earliest application of the mechanical arts was the construction of machines for the measurement of time, and a perusal of the older treatises shows how much ingenuity was devoted to them. Thus it happens that horology was at an early date in a comparatively high state of development, and was not in the same need of radical changes as were most of the other arts of construction. It may further be added that the results attained, as regards timekeeping, have been eminently satisfactory, so that the arguments in favour of a change of system must be based rather on facility and economy of manufacture. These latter, as will be seen from the next lecture, are now forcing themselves on our attention in a manner that they have not hitherto done.

In the preceding historical notice, I have had to refer to many subjects doubtless unfamiliar to some of you, but it did not seem desirable to prolong this branch of the subject by the addition of explanations, that can be better given in the course of the more detailed consideration of the pocket watch, upon which I now propose to enter.

A watch consists essentially of three parts—(1) the driving mechanism; (2) the controlling and regulating mechanism; (3) the indicating mechanism. Fig. 10 (p. 674) represents the mechanism of a full plate watch, or of a marine chronometer, the top plate, together with the escapement, having been removed.

The barrel contains a coiled spring to serve as a motive power, and is connected by a chain with the fusee, which serves to render uniform the force transmitted to the train. From the figure it will be seen that, as the watch is wound up by a key on the fusee axis, the chain is unwound from the barrel and wound on to the fusee, which may be defined as a screw of rapidly diminishing diameter. When the spring is fully wound up, and therefore exerting its maximum force, it acts at the extremity of the shortest power arm, or radius, of the fusee, and this arm gradually increases as the force exerted diminishes. Within the fusee is the maintaining power for keeping the watch in action during the time of winding. The centre wheel, whose pinion is driven by the fusee, carries the minute hand, and engages with an intermediate or third wheel. This drives the fourth wheel, on the axis of which is the seconds hand, and the escape-wheel seen in the middle of the figure is driven by the seconds wheel. The axis of the centre wheel below the plate carries, friction-tight, a pinion of twelve leaves, which, through a wheel and pinion of 48 and 14 respectively, drives a wheel of 42 teeth concentric with itself. The relative rates of these are as 1 is to 12, so that the hour hand travels 1-12th as fast as the minute hand.

The maintaining power seems to have been first introduced by Harrison, in 1736. Fig. 11 (p. 674), although not strictly accurate, will serve to explain the principle on which it acts. The mainspring causes the fusee to rotate in the direction of the hands of the watch, or towards the right. It will be evident, then, that, if the fusee and its wheel were solid, the pressure of the hand in winding, which turns in the opposite direction, would neutralise this motive

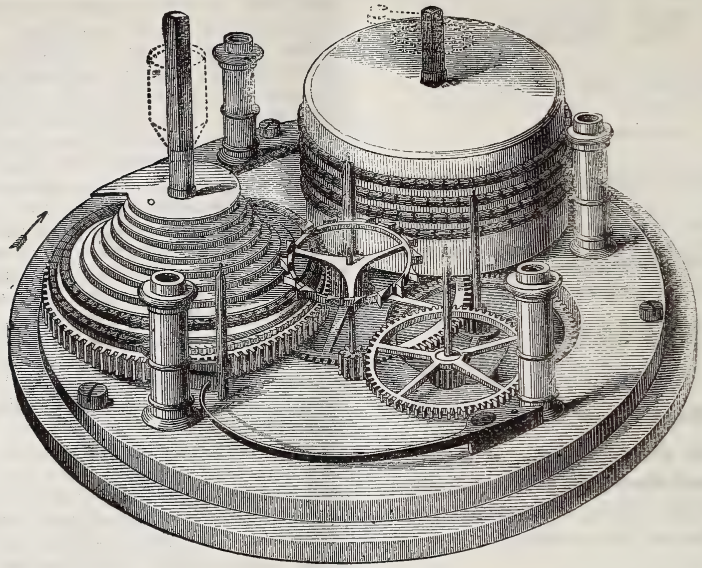

Fig. 10.

force, and the watch would stop. Such an inconvenience is prevented by the maintaining power. The brass ratchet wheel in the centre is rigidly fixed to the under side of the fusee; side by side with it, and loose on the same axis, rotates a steel wheel provided with very fine ratchet teeth, cut in the opposite direction to those of the brass ratchet wheel, and carrying two clicks held by springs against this latter wheel. A detent fixed to the plate engages with the ratchet teeth of the steel wheel, and the brass fusee wheel below, which is not represented in this figure, but will be noticed in Fig. 10, communicates motion to the train. A recess in this wheel contains a flat circular spring, indicated by the shaded portion of Fig. 11, one end of which is attached to the steel wheel, and the other to the brass wheel.

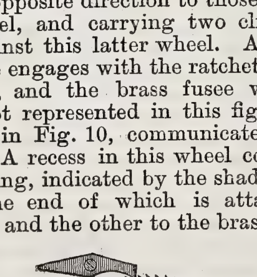

Fig. 11.

Now, assume the mainspring to be wound up. The fusee, with the brass central ratchet attached, tends to rotate to the right, and, through the clicks, communicates the impulse to the steel wheel; this impels the fusee wheel, at the same time maintaining the circular spring compressed. While the watch is going, then, the teeth of the steel ratchet pass freely under the detent. But consider what occurs when the fusee is rotated in the opposite direction, during the act of winding. The brass ratchet passes under the clicks, and the steel one is locked by the detent. The circular spring, therefore, maintains its constrained position, the end attached to the steel ratchet being held stationary: its elastic force is expended in continuing the impulse on the fusee wheel, and this action will be maintained for a period dependent on the extent to which it has been compressed.

Reference has already been made to some points in which the ordinary Swiss watch differs from that of English make. I would only here mention the suppression of the fusee, whereby the maintaining power is rendered unnecessary. The spring barrel is provided with teeth, which engage directly with the pinion on the axis of the minute wheel, and, in winding, the inner end of the mainspring is coiled on to an arbor in the centre of the barrel; the barrel, therefore, is constrained to revolve in the same direction as by the spring during its uncoiling. Hence there is, as it were, a continual movement of advance of the spring; whereas, when a fusee is used, one end of the spring always remains stationary, and it coils and uncoils about the same mean position.

This distinction causes the first to be designated a going barrel, and it is gradually coming into more general use, in watches other than those controlled by the cylinder escapement. The arguments put forward for and against each form of barrel are very numerous, and I shall presently refer more specially to the question, as it constitutes a main distinction between the ordinary English and the continental or American watches; it is often regarded as the essential point on which English and foreign horologists differ.

The bearings of the question as to whether the suppression of the fusee is desirable or not will, however, be better appreciated when the escapements commonly used in watches have been ex-

plained, as the degree of uniformity required in the motive power will necessarily depend on the power of the escapement to neutralise its irregularities, a power which varies considerably.

An escapement, it will be understood, is an appliance adapted to the end of a train of wheels in order to prevent a too rapid motion, and at the same time to regulate the expenditure of the motive force in such a manner that it is allowed to exhaust itself with the requisite slowness and uniformity. The variety among escapements is very great; many are suitable for stationary timekeepers, while being quite unfitted for such as are constantly moved about; some are adapted to the slow movement of a pendulum, but cannot be employed without modification with a balance. Those ordinarily met with in watches, and which alone I shall briefly consider, are five in number, the verge, cylinder, duplex, lever, and chronometer, or detent escapements. Let us take them in the order here given.

The verge escapement was the first employed in timekeepers, having been invented sometime between 1000 and 1400 A.D. It has been assigned to John Megestein, a clockmaker of Cologne, in the fourteenth century, and was the only escapement known up to the middle of the seventeenth century. An early form is shown in Fig. 1, on page 666, from which it will be seen that a vertical rod, suspended at its upper end and terminating in a pivot, carries two pallets that engage with a crown wheel having ratchet teeth, and to the upper end of the rod two horizontal arms are fixed, that support equal weights. The pallets are inclined at an angle of about 100° to each other, and it will be seen that if a motion of rotation is given to the wheel, its teeth will alternately engage with the pallets, and impart an oscillatory motion to the system. By moving the weights towards or from the centre, the period of this oscillation can be varied, and the rate of motion of the train of wheels thus regulated. If a balance with fixed weight be substituted for this folliot, as shown in Fig. 2, on page 667, and the whole be supported between two pivots, it will be seen that such an escapement is portable, and, further, it possesses the property of continuing to go, even although unprovided with a balance-spring, as was the case until the seventeenth century. Thanks to the kindness of Dr. Longton, of Southport, I have here such a watch. It bears the name of David Lestourgeon, of Rouen, and possesses special interest, both on account of its being unprovided with a balance-spring, and owing to the fact that a catgut band is employed in place of the well-known chain on the fusee. Its date is probably about 1640. All its parts appear to be original, and the watch is still in going order.

The principle of the verge escapement is met with in Sully's marine clock, already described, and elsewhere, and the celebrated French horologist, Berthoud, had an extraordinary fondness for it. There is no question that very good results have, at times, been secured with the verge, but to obtain them requires all the ability of the most skilful workman, and his time is far better employed on the superior class of escapements. A main objection to it consists in the fact that, the motive force being always applied to the balance, any slight variation in this force causes a change in the rate; hence a very carefully adjusted fusee is essential, and the adjustment must be corrected whenever a new spring is fitted. The working parts are subject to rapid wear, and the use of an escape-wheel, in a plane perpendicular to the plates, renders a thick case necessary.

It is worthy of remark, that the objections to a verge escapement in a watch, do not apply with nearly the same force in a clock; and the common "Comté," Dutch, and other clocks are known to be fair timekeepers. This difference arises from the fact that the arc of vibration is so small; and M. Wagner has proved experimentally that the verge is all the more capable of giving accurate results, as the oscillations are made shorter.*

To turn to the brief consideration of the cylinder, Geneva, or horizontal escapement. As already stated, it was invented by Graham, in 1700, and, for a reason that will soon appear, it is classed by Saunier as a "frictional rest" escapement. Fig. 12 represents an inverted plan of the escape-wheel teeth and cylinder, and Fig. 13 (p. 676) is an elevation of the entire escapement also inverted. The upper portion of the cylinder carries a brass collet, to which the balance is rivetted, and the cylinder itself is a steel tube, half of which is cut away throughout a portion of its length, and three-quarters through rather less than half of this portion. The wheel is provided with teeth projecting downwards from the plane of the paper in Fig. 12, and terminating in triangular formed heads.

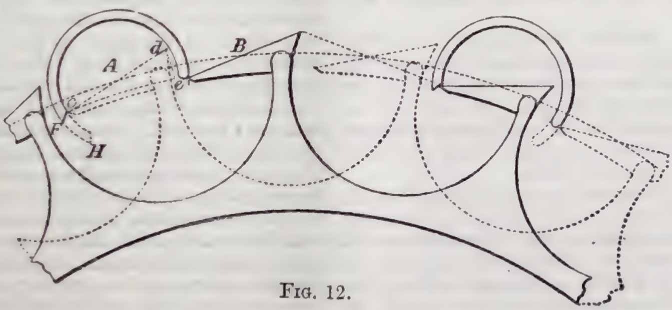

Fig. 12.

Two successive positions of the cylinder in relation to a tooth are indicated in Fig. 12, the wheel being impelled in the direction from right to left. A tooth, B, coming in contact with the edge (e) of the cylinder, A, causes it to rotate in the direction opposite to the hands of a watch until the heel of

* Saunier, "Treatise on Modern Horology," p. 67.

B escapes from the edge, and its point falls against the inside of the cylinder at *c*. The cylinder and balance continue to rotate through the impulse that has been communicated to them, until they are

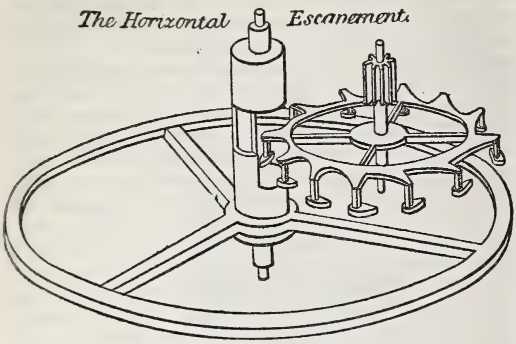

FIG. 13.

brought back by the action of the balance-spring. Rotating now in an opposite direction, the tooth is released from the inner surface of the cylinder and gives a fresh impulse against the edge, H, as soon as it reaches the point, F, and when the tooth, A, is released, the next tooth falls against the outside of the cylinder; the balance-spring now brings the whole back again, and a similar series of actions recurs. The reason for the distinctive term, "frictional rest," will now be evident. It refers to the fact that, during the entire period the escape-wheel is at rest, there is friction occurring between the point of a tooth and the inside or outside surface of the cylinder, and this friction, slight though it apparently is, is a most important feature of the horizontal escapement; for if, from any cause, the motive power increases, the pressure of the point of a tooth on the cylinder increases proportionately. The friction therefore increases, and the watch goes slower. There is thus a kind of natural adjustment that more or less exactly makes up for variations in the motive force—indeed, it was observed by Jodin more than a century ago, that if the balance is too large, the watch goes slower with an increase of the motive force, and, conversely, when it is too small, it goes faster. It will thus be seen that this escapement possesses one important advantage over the verge: it does not necessarily involve a uniformity in the motive force.

With a view to diminish the friction and wear of the cylinder, it has been made entirely of ruby, but such a construction is difficult and costly, and the rate obtained is not superior to that with a well-made steel cylinder. I shall not, therefore, stop to further describe it in this hasty sketch of the escapements in ordinary use.

The first idea of the duplex is attributed to Dr. Hooke, who employed a two-balance escapement in the watch he designed, in 1660, for Charles II., a watch that possesses considerable interest as being the first to which a balance-spring was applied. It was, however, materially modified by Dutertre, P. Le Roy, and Tyrer, the latter of whom gave it the form shown in Fig. 14. The escape-wheel is provided with two sets of teeth; a long pointed series, whose office it is to arrest the movement of the train immediately after an unlocking has been effected by the balance, and a series of triangular teeth projecting upwards from the flat of the wheel, by which the impulse is

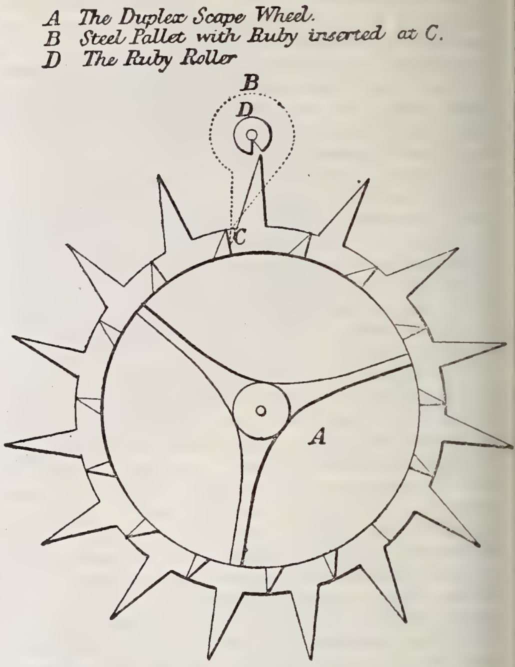

FIG. 14.

communicated to the balance. In the earlier forms of this escapement, there were two wheels on one and the same axis, but its principle was of course the same.

The axis which carries the balance and balance-spring is at D. It also carries a small cylindrical tube of ruby, in which a notch is cut as shown. Above the roller is a steel arm, B, provided with a ruby pallet, C. The axes of the balance and escape-wheel, A, are so pitched that the points of the resting teeth, although being held against the surface of the ruby roller, do not reach the bottom of the notch in it (in the figure they are, by an engraver's mistake, set too far apart). The figure represents an impulse to the pallet C, which together with the balance, will continue to rotate in a direction opposite to that of the hands of a watch, *i.e.*, from right to left; during this revolution the resting tooth will remain against the roller. On the balance being brought back by its spring, the escape-wheel will remain stationary, except when the resting tooth drops into the roller notch. When the spring brings it back a second time, all the parts assume the positions shown in the figure, and a fresh impulse is applied. From the above explanation, it will be seen that the duplex resembles the cylinder escapement in having a frictional rest; but, as this friction occurs at a greater distance from the escape-wheel axis, and a less distance from that of the balance, its effect in reducing the freedom of motion of this latter is proportionately less. But this friction must have a certain influence in enabling the escapement to neutralise variations in

the motive force, as in the one last considered; and the two further resemble one another in possessing a kind of natural compensation for variations of temperature. In both, the points of the teeth require to be provided with oil. Now, it is well known that in the cold the elastic force of a balance-spring increases, and it has a tendency to accelerate the rate. But cold will also increase the consistency of this oil, and, therefore, the friction —or, rather, the adhesion; thus, to some extent, counteracting the accelerating effect of the spring. Although it would be too much to pretend that these two influences always neutralise one another, the effect is sufficient to render a compensation balance far less essential than it is in detached escapements, such as the lever and detent; indeed, it would be inapplicable, on account of the variability of this adhesion with time.

The duplex is unquestionably a beautiful device, and capable of securing very uniform timekeeping, but accurate workmanship is in the highest degree essential. For this reason, and owing to the fact that it is liable to be disturbed in its action when carried, the duplex is considered less satisfactory than the lever, which, for the same degree of ability on the part of the workman, secures a better rate.

There are many varieties of the lever escapement, but that most frequently made in England, and known as the English lever, is shown in the diagram (Fig. 15). This escapement is by far the best that

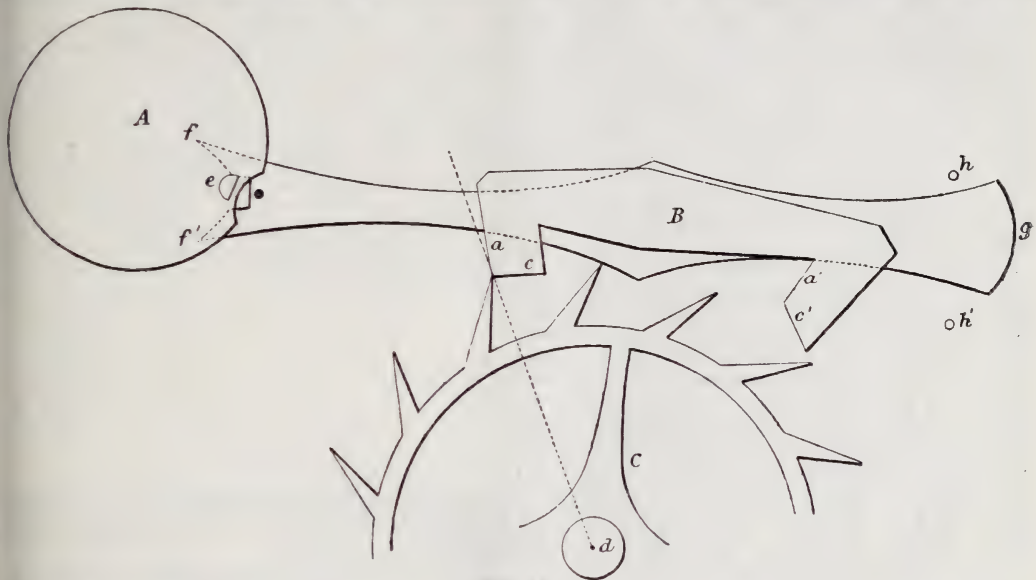

Fig. 15.

has yet been devised for portable timekeepers, and is rapidly displacing all others, even the cylinder; I have already referred to some of its earlier forms.

The arrangement adopted by Mudge, in place of the rack and pinion of Hautefeuille (Fig. 8, p. 670), is somewhat difficult of construction, and has since been simplified, but the principle remains precisely the same. Indeed, it is worthy of note that in the most approved form of the lever escapement, known as the double roller, we have a remarkably exact copy of Mudge's original design.

In the ordinary English lever the balance is carried on the axis, A, on which is also a steel discs or roller, carrying a semi-circular ruby pin, *e*, and cut away in crescent form, as indicated. The impulse is communicated by the escape-wheel teeth to the two faces, *c* and *c'*, of the "pallets," which are pinned to a light steel lever, *e g*. At the extremity (*e*) of this lever is a notch, into which the ruby-pin enters during its rotation, and a brass pin, indicated by a black dot, and termed the "guard-pin," whose office will be presently evident. Consider the several parts in the positions shown in the diagram, and the balances rotating to the hands of a watch. The ruby-pin, *e*, having just entered the notch, lifts that end of the lever, and releases the tooth from the locking face, *a*, of the pallet, *a c*. In traversing this pallet, the tooth will communicate its impulse to the lever, and the ruby-pin will be impelled forward by the lever side of the notch, until, when the lever rests against the opposite pin, *h'*, it escapes from the notch, and during the remainder of the vibration the balance is entirely detached. The tooth falling against the locking face, *a'* will maintain the lever stationary, but, in order to avoid any accidental displacement, the guard-pin near the notch, already referred to, is added. This is almost in contact with the roller on the axis, A, so that the lever cannot leave *h* or *h'* except when the guard-pin is opposite the crescent in this disc, in other words, when the ruby-pin is receiving its impulse from the notch in the fork. The elasticity of the balance-spring causing the return of the balance with the attached roller, the ruby-pin will again enter the notch, travelling in an opposite direction, and will receive a further impulse from the tooth acting on the pallet, *a'*.

It is very usual, both here and abroad, to distribute the incline between the teeth and pallets, and some makers have transferred the inclines entirely to the teeth, giving the pallets the form of English escape-wheel teeth. The principle of the escapement, of course, remains the same, whatever form is adopted, and good

results have been obtained from all. It cannot be denied, however, that the pointed teeth are less made than formerly; they possess advantages in that they allow more oil to be retained on the surface of the pallet, and are more easily made. On the other hand, with club teeth the friction is distributed between two points instead of one, the oil is retained on the acting surfaces better, and the drop, or distance travelled by the wheel between leaving one pallet and reaching the other, can be reduced indefinitely.

The club-tooth has been generally adopted in factories for ordinary watches, and it is unquestionably less liable to damage by rough usage, but its adjustment is said to be more difficult, and for equal accuracy in timekeeping at moderate cost, it seems doubtful whether the ratchet-tooth is not to be preferred; it will certainly be less influenced by variations in the thickness of oil. But both forms possess special advantages, and the selection must be left to experience. Just as there are varieties in the wheel and pallet action, there are varieties in that of the fork and roller; but, having described that most commonly met with, I must not spend more time in their consideration, as they possess no special features of interest.

It remains for us to briefly consider the chronometer or detent escapement, as it is occasionally employed in pocket watches. Although it is without question by far the best for the marine chronometer, many competent horologists maintain that a mistake is made when this escapement is used for watches, as its action is liable to be disturbed by shocks; so that, while more expensive than the lever, it is, for a watch, not superior to it as a timekeeper. The detent escapement was devised by P. Le Roy, and applied by him to a marine chronometer in 1766. Its form was, however, modified by Berthoud, Arnold, Earnshaw, and Breguet, so that its present form cannot be claimed by any single inventor. The design usually met with is shown in the diagram. At F is the axis of the balance, which is, as in the previous cases, omitted in order to avoid confusion. On this are carried two steel discs, F and E, in which ruby pallets are fixed. A is the escape-wheel, one tooth of which is represented locked against a ruby, b, carried on a spring arm, B b, to which a very light gold spring, D D, is fixed. Consider the balance to rotate in the direction of the arrow, the pallet in F will merely raise the spring, D D, out of contact with the extremity of B b, and the balance will continue its movement until arrested by the action of the balance-spring. In the return vibration, the pallet, instead of merely raising D D, will force the entire piece, B b D, towards the right, releasing a tooth of the escape-wheel. A tooth will immediately fall against e, and communicate the impulse to the balance, and the spring will fall back into its place by its own elasticity, arresting the movement of A. The balance, then, receives one impulse for each double vibration, and in this respect the escapement resembles the duplex.*

Having now briefly described the more important escapements met with in portable timekeepers, it will be well to say a few words in regard to their relative merits. The first three described, the verge, cylinder, and duplex, are always under the influence of the motive force, whereas, in the lever

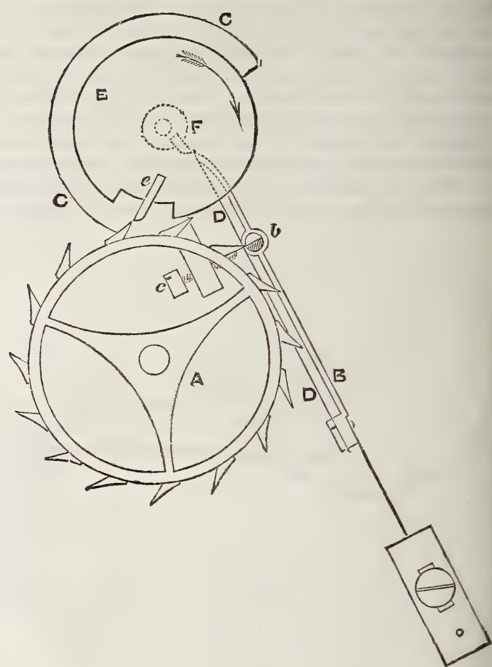

Fig. 16.

and detent escapements, the balance is only engaged during brief intervals to unlock the escape-wheel and receive the impulse.

Now, in every well made balance-spring, providing it be of sufficient length, there is a length that possesses the property of isochronism, in virtue of which all the vibrations of an attached balance, of whatever extent, within moderate limits, are performed in equal intervals of time; and an isochronal vibration is characterised by the fact that the force exerted by the spring is always proportional to the angle through which the balance is turned from its position of rest. But in every form of escapement there is a period during which the balance receives its impulse, when the character of the movement is so changed as to be destructive of theoretical isochronism. As, however, this is a regular influence occurring at each vibration, it is quite possible to take it into account, so long as it does not vary beyond moderate limits, and thus to secure practical isochronism. But if the impulse varies beyond these limits, the vibrations are no longer performed in equal times, and hence we see why it is that in the lever and detent escapements a very near approach to uniformity in the motive force is essential; as the variations in this force gradually increase, the difficulty in adjusting the isochronism will proportionately increase until a point is reached beyond which it becomes impossible. The irregularity in the restraint put upon the balance in a cylinder escapement renders an isochronal spring

* The mode of action of the detent escapement was further illustrated by means of a beautifully-executed working model, for which the lecturer was indebted to Mr. S. Jackson; and that of the lever escapement by a similar model, kindly lent by Mr. Tripplin.

a useless expense, and the same may be said in a less degree of the duplex.

These considerations lead me to refer more particularly to that much vexed question as to whether it is advisable to retain the fusee in the English watch, seeing that it has been abandoned in every other watch-producing country. I venture to think that, in writing on this subject, many watchmakers have missed the real point at issue, and that the advocates of both views have right on their side. In the first place, it is no sufficient test of high-class timekeeping to observe the rate only at intervals of say, 24 hours, when an equal period elapses between successive windings up. Absolute coincidence with the regulator under such conditions only shows that any gain during the first 12 hours, when the higher turns of the mainspring were in action, was neutralised by a loss during the last 12 hours. Let us, therefore, consider a going barrel and fusee watch that, while being wound up every 24 hours, show an equally good rate when examined at intervals of 12 hours, all question of compensation for temperature being of course eliminated by maintaining them at the same degree of heat, the positions also being the same. The motive force with the going barrel is certainly less constant than with the fusee [a fact which was practically demonstrated by means of a lever, with a sliding weight, fixed to the winding square of a fusee watch and of a going barrel watch successively, the escapement being in each case removed. It was shown that each turn of the fusee was able to lift the lever without altering the position of the weight; but, with the going barrel, this weight had to be gradually moved towards the centre, to correspond with the decreasing motive force]. As we have seen that the adjustment of the isochronism becomes more difficult as the variations in the impulse become greater, the conclusion to which we are forced is that more skill has been required to adjust the going barrel watch. It is obvious that the amount of variation in the arc of vibration depends on several conditions that may be more or less favourable. M. Philippe found,* as the result of a great number of experiments on going barrel watches, that this variation varied from 112° to 65° in 24 hours according to the form of spring and the mode in which it was fixed in the barrel, but he does not state the extent of the initial arc. The curve in Fig. 17 exhibits the results of experiments made by M. H. Robert† on the same subject. He found that, by increasing the motive force in one of his going barrel chronometers from 300 grammes to 2,500 grammes, the arc of vibration increased gradually but not uniformly from 135° to 490°. Mousquet,‡ in discussing these results, directs attention to the remarkable fact that, if we take

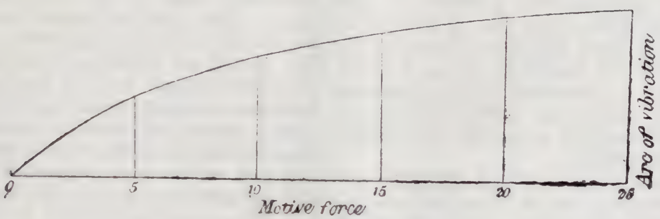

Fig. 17.

as a measure of the efficacy of the impelling force the square of the arc of vibration divided by the force itself, we shall find a maximum at the point corresponding to 370° arc of vibration, and a motive force of 1,300 grammes. Of course, this number is influenced by a great variety of circumstances connected with the construction and design of the chronometer, so that it cannot hold good in all cases; but the subject is well worth investigating by means of a number of chronometers of different makers, as there seems good reason to suppose that it would afford a datum for determining by experiment the most advantageous motive power in any given case.

Side by side with this curve of M. Robert's, I have placed two curves, Fig. 18, representing the gradual change in the strength of mainsprings on the same well-known principle of the indicator diagram. They are selected from a number given by M. Saunier,* and the upper curve, B B, refers to a spring for a watch going 15 days, while the lower one, A A, belongs to that of an ordinary lever watch of the same general dimensions, and, apparently, with a going barrel. A few words will suffice to explain the mode in which they are drawn. Heights measured on the equi-distant vertical lines represent the force of the spring, and each of the equal horizontal spaces corresponds to one complete turn of the barrel. Thus, the diagram

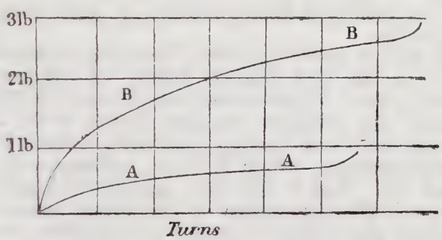

Fig. 18.

shows that spring, B B, makes about 7 turns, and A A makes only 5½. Assuming 5 turns of B B to be used in the course of the 15 days, we see that the impelling force will vary from about 2·6 lbs. to 1·3 lbs., so that if its initial arc of vibration was 370°, its final arc, judging from Robert's curve,

* "Treatise on Modern Horology," p. 670.

* "Journal Suisse d'Horlogerie," II. (1878), p. 201.
† "Revue Chronométrique," I. (1856), p. 102.
‡ "Revue Chronométrique," II. (1858), p. 216.

will only be about 275°. The one-day spring is characterised by the same degree of variation. Assuming four turns to be brought into action, the initial impelling force is 0·7 lb., and that at the end 0·35 lb., so that, with the same arc when fully wound up, it will fall to about 275°. This spring, A A, is evidently a good specimen for a going barrel watch, as may be judged from the flatness of its curve, and yet its isochronal adjustment will require to be correct, through a range of at least 100°.

I have taken the maximum arc of 370° as being that to which the investigations of M. Mousquet point as the best. It is, however, important to remember that they can only be regarded as applying to the particular watch or chronometer of M. Robert's that he is discussing, and in any other watch a different angle would probably be found to correspond to this maximum effect, dependent on various conditions as to the escapement, &c.

I must not omit to mention a further important advantage, secured by rendering the motive force uniform by the aid of a fusee. Probably the most neglected adjustment in a watch is that which is necessary in order to ensure an equal rate in varying positions. When lying flat the friction is, as a rule, less than in a vertical position. The rate is therefore seriously modified by the change, and, on altering the position of the watch in a vertical plane, the rate is subject to still further modification, mainly owing to the influence of gravity. It would be of no general interest to attempt a discussion of this question, but I will only add, that, if the motive force is not approximately uniform, the requisite adjustment becomes almost impossible.

The additional cost of a fusee is so slight as not to be worth considering, and it seems fair to conclude that, if in such high-class watches the fusee and chain are abandoned, additional care and skill must be devoted to the isochronal and other adjustments, and there will be an increased risk of derangement in the cleaning, &c., by any but the most skilled hands. The number of springers competent to undertake the best work is already so limited, that it seems most unwise to risk further reducing their number by increasing its difficulty.

It will be understood that I have hitherto spoken only of the very highest branch of the watchmaker's art. Whether the fusee should be retained in ordinary watches—watches, that is, which have to compete with foreign produce—involves other considerations, which I hope subsequently to refer to. But it will be a matter of regret if, in the highest branches of the watch trade, the fusee is abandoned in favour of the going barrel, as we have it in the present day. I have not seen that any advocates of the fusee in the recent discussions have drawn attention to the fact that Henri Robert, a strong advocate of the going barrel even for chronometers, urged that the fusee should be retained in high-class watches,* because the space available for the barrel is limited, and it is therefore impossible to employ a mainspring with 10 or 12 turns, as in his marine chronometers.

There have been few such earnest advocates of the going barrel as M. Robert, and his testimony in favour of the English practice is therefore of special value. And he is far from being alone in this matter. It has become the fashion at the present day to upbraid English makers for retaining the fusee; but if anyone will study the horological literature of the Continent, he will be surprised to find how many of the best known authorities are favourable to its retention in the case of high-class watches. Besides affording a ready means of equalising the motive force, the fusee possesses yet another very important recommendation. If an ordinary mainspring be fully coiled up in a barrel so as to "choke" on the arbor, forming, as it were, a solid block, and then allowed gradually to uncoil, the inner coils will remain in close contact, and the outer ones will be the first to release themselves. Thus the motive force due to such a spring will, throughout the greater part of its uncoiling, be modified by the adhesion between these coils, diminishing as the oil becomes thicker. The variability in the motive force is, then, itself a variable quantity. Now, if instead of being of uniform thickness throughout, the spring be suitably tapered, so that the thickness increases gradually from within outwards, it is evident that the coils may all be caused to separate from the first, for the tendency of the outer coil to expand is greater relatively to the mean strength of the spring, than it is in the case of uniform thickness. As all the coils are, therefore, apart throughout the period of winding, the irregularity due to variable friction, &c., is, in great part, avoided. But such a spring could not be used in the going barrel, since there is even greater variation in the force exerted as it runs down than in the ordinary —a fact which was prominently brought out in the experiments of M. Philippe, above referred to. The correcting action of the fusee is, therefore, the more requisite.

The difference in the mode of unwinding of the two forms of spring, is exemplified by the three Figs. 19, 20, and 21 (p. 681). The first of these shows a mainspring fully wound up, so that all the coils are in close contact. A spring of uniform thickness begins to open out in the manner indicated in Fig. 20, and must evidently occasion a considerable variability in the motive force owing to adhesion. The tapered mainspring, as used in the best English watches, will open out somewhat in the manner indicated in Fig. 21, so that the influence of adhesion is in great part avoided.

The fact that the fusee is of such value should serve as a stimulus to the invention of improvements in the going barrel, for there certainly are real objections to the ordinary form of the English watch, and a reliable going barrel, that secures an equally uniform transmission of force, is much to be desired, as it would form a starting point for the designing of a new calliper. Many changes have been suggested with which, however, I will not now detain you, and more alterations have been proposed in the escapement on account of the variability in the motive force than from any other cause; but none of these have been permanently and completely successful, as compared with a well-constructed fusee and chain. Many of the objections so persistently urged against this construction, though well deserved in

* "Revue Chronométrique," vol. i. (1856), page 109.

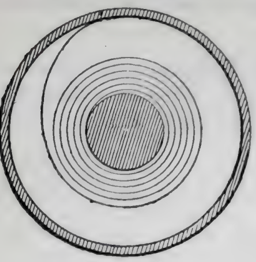

FIG. 19.

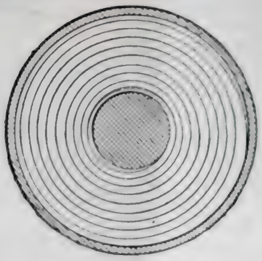

FIG. 21.

FIG. 20.

the case of cheap watches, are utterly unreal as regards the well made and highly adjusted English watch. Thus, it is frequently asserted, that they are difficult, if not impossible of repair by country watchmakers; but, I would ask, is a workman who cannot repair a fusee the proper person to be entrusted with a highly adjusted watch at all?

Having now considered the precautions that are taken with a view to avoid or neutralise variations in the motive force in a watch, it remains for me to say a few words in regard to the other principal source of irregularity—variations of temperature. Those who desire a fuller discussion of the question may refer to a paper which I read before the Society of Arts, in March, 1879, on "Compensation."*

When the temperature of a balance-spring is reduced, its elastic force becomes greater, the vibrations are therefore performed quicker and the watch gains; the converse is the case when heat is applied. Now the period of vibration of a balance depends on the distance between the axis of rotation and the rim, varying directly with this distance, so that if the radius can be reduced in a manner exactly corresponding with the reduction in the elastic force, the rate will, theoretically, remain the same at all temperatures. Such an absolute adjustment has not yet been secured, but a very close approximation has been reached, and the balance shown in Fig. 9, p. 671, is sufficient for all pocket watches and is universally used. It will be seen that the rim, instead of being a continuous circle of brass, steel, or gold, is formed of two metals, brass and steel, with the former on the outside, and it is cut through in two places. Small gold screws are inserted at intervals round the rim, and the principle of its action is as follows:—The expansion of brass for a given rise of temperature is greater than that of steel; the composite arm, then, will become more curved when heat is applied, and the free extremity will move inwards towards the axis of the balance, carrying with it of course the gold screws. Thus the action is equivalent to a reduction in the diameter of the balance since the greater portion of its weight is brought in towards the centre, and the adjustment of the compensation consists mainly in so placing the screws that this effect shall be proportional to the change in the elastic force of the spring. Many other forms of balance have been suggested for use in chronometers, but the one described is almost exclusively used in watches, and secures a very high degree of regularity, if properly adjusted. But by no means all of the watches provided with these balances are so adjusted, and in very many cases a good plain balance is to be preferred, especially in a moderate priced watch. At the same time it is probable that a well-proportioned compensation balance with cut rim, that is unadjusted, will do something in the direction of counteracting the effect of variation of temperature, an effect that, according to Delamarche and Ploix,* amounts to about 11 seconds per 24 hours per 1° C.

The compensation balance, like the isochronal spring, is not equally applicable to all forms of escapement. Thus the verge is subject to such variable influences that the irregularities due to temperature are only a few of those to which it is liable; the cylinder and, to a less extent, the duplex, have a natural power of compensation, as already explained, just as they have a natural isochronism. But, for reasons similar to those already given when speaking of isochronism, the lever and chronometer escapements in their highest perfection require it.

Hasty though this account has been, I trust I have said enough to indicate what intelligent and skilled work is required for the adjustment of a watch, even after all its parts have been properly constructed. The degree of perfection now attained to is, in a sense, more remarkable than that of the marine chronometer, for, besides being of smaller dimensions, it involves an additional and troublesome adjustment, that for position. The productions of some of our best makers are really remarkable for their accuracy, a watch that does not vary more than half a second in 24 hours, in different positions, being frequently met with. Now, as it is physically impossible to secure absolute perfection, I am disposed to think that this must be regarded as a near approach to the limit to be attained with certainty. In what direction then must future advance be looked for? There seem to be only two possible avenues. A more general distribution of high-class timekeepers and, as tending in that direction, a simplifying of their construction, and therefore a lowering of their cost of manufacture.

Watchmakers may be disposed to doubt the possibility of simplifying the English watch, but they should remember that the history of all radical improvements in machinery exhibits a tendency towards simplicity; where the converse appears to be the case, it will generally be found that a tool or instrument has been made more automatic.

With regard to the more extended use of high-class watches, I would refer to a practice much in vogue in Switzerland, which it is stated has greatly helped to extend the trade. I mean the testing of watches at an observatory, as marine chrono-

* "*Journal of the Society of Arts*," vol. xxvii. (1879), page 342.

* "Comptes Rendus," xlviii 241., (1859).

meters are tried at Greenwich, or thermometers at Kew. The rate-papers thus obtained have doubtless been in many cases utterly valueless and misleading, owing to the fact that the commonest watch may often be found to go with remarkable regularity for a limited period, but if the trials were continued for a sufficient length of time, under varying conditions, by a properly-constituted authority, they could not fail to be of great service, as affording reliable evidence of the degree of accuracy to which our best makers have now attained. Foreign competitors have found the advantage of such guarantees, and it is impossible but that they should be of use here. They might almost be compared to the hall-mark on a piece of plate, which affords a security that cannot be gainsaid, and is independent of the faith that the buyer may or may not have in the seller.

One other point, in regard to these rate-papers, which affords food for thought to English makers, and should, I venture to think, stimulate them to renewed efforts. Dr. Hirsch, the director of the Observatory at Neuchatel, publishes, in his annual report, a statement, showing the mean of the results obtained on watches submitted for trial. These results, for the last 15 years are as follows:—

Variation (in Seconds).

Year.	Daily.	Lying and Hanging.	Per 1° C.
1864	1·27	8.21	0·48
1865	0·88	6·18	0·35
1866	0·74	3·56	0·36
1867	0·66	3·57	0·16
1868	0·57	2·44	0·15
1869	0·60	2·43	0·14
1870	0·54	2·37	0·14
1871	0·55	1·90	0·13
1872	0·52	1·99	0·15
1873	0·62	2·59	0·15
1874	0·53	2·27	0·15
1875	0·46	1·97	0·13
1876	0·53	2·16	0·12
1877	0·51	1·98	0·11
1878	0·60	2·10	0·10

The general conclusion to which these figures point cannot be mistaken, and English makers may well envy their Swiss brethren the possession of so satisfactory a record of progress.

In concluding, I would refer to one other means by which the demand for high-class watches might perhaps be increased. As Mr. Ellis* has pointed out, the establishment of public clocks indicating seconds, besides being of very great convenience to chronometer-makers for testing their regulator clocks, may induce purchasers to become possessed of timekeepers of high quality, as they will have the means at their disposal of verifying their accuracy. The distribution of true time is becoming every day more general, so that we may hope this influence will be felt by the trade.

[The following blocks have been kindly lent to illustrate this lecture:—Fig. 1 (on p. 666) taken from Saunier's "Treatise on Modern Horology," by Mr. Tripplin; Figs. 10 and 11 are from Sir E. Beckett's "Clocks, Watches, and Bells" (Crosby Lockwood & Co.), 1874; Figs. 9 (p. 671) and 16 by the editor of the *Horological Journal*; and Figs. 12, 13, 14 by Messrs. Spon.]

* *Journal of the Society of Arts*, vol. xxvii. (1879), p. 356.

DOMESTIC ECONOMY CONGRESS.

(*Report continued from p. 672.*)

The meeting of Friday, 24th June, was held at the Society of Arts, the Viscountess Strangford in the chair, and Lord Alfred S. Churchill, assessor.

Section D 1. — Rules for Health and Management of the Sick Room.

Lady Strangford read a paper on "Teaching Laws of Health in Elementary Schools."

Sir Henry Cole said that nothing more touching, simple, or convincing, even to Whitehall officials, had been read in the Congress. Lady Strangford had entirely proved her case, that a knowledge of their bodies would lead most effectually to the acquirement of other education in the shape of reading, writing, and arithmetic. The ladies of the Congress ought to give the Lords of the Council no peace until they had made them learn by heart Lady Strangford's paper.

Mr. Chadwick recommended the formation of a class for practical teaching in this direction, and that an account should be given of the working of it. Putting forth mere generalities was not sufficient, and principles to be of any value should be proved and tried. He was acquainted with a lady who had laid down a rule to allow no colds in her house, and her resolution, of course, entailed care on her part that the servants and members of her household should not remain or work in damp clothes, and that all other inducing causes should be prevented.

Sir Henry Cole thought if women would conduct their households by laying down such rules as that colds should be banished, and could carry them out by method, we should have gone very far in the right direction.

Paper read by **Miss Mary Martineau** on "Teaching the Laws of Health in Schools."

Mr. Chadwick said knowledge so exceedingly good should be particularly addressed to the superior authorities, because even in the construction of the Board schools, a great deal of information was wanted upon the subject. The very structure in which a Board conducted their deliberations, and which had cost a large sum of money, had proved to have been erected in violation of sanitary laws, and a lady member was recently made very ill from sitting over a ventilating grating in communication with an old sewer which had been allowed to remain there. Needless to say, the defect was soon remedied, and the sewer bricked up. Evidently, a body so unacquainted with the laws of health, required considerable instruction. In two schools connected with that body, where he had seen filthy children massed together, in defiance of sanitary rules, the cases of sickness reached 30 per cent., while in another, conducted in accordance with the laws of health, the per-centage of illness was only 10 per cent.

Paper read by **Miss Peechey, M.D.**, on "Teaching Rules of Health in Elementary Schools."

Mrs. Sutherland Orr's paper, on the "Desirability of Introducing a Practical Knowledge of the Laws of Health in the Lower Standard of School Board Education," was read by **Lady Strangford**.

Mrs. Priestley entirely concurred in the paper, which really embraced her own idea that the subject was too much elaborated with science to be of any real practical use. If we could divest our views and methods of teaching of a good deal of science with which they were mingled, more practical results would be obtained. It was, after all, a very simple matter, and should be taught in the simplest manner, especially to children.

Sir Henry Cole quite agreed that too much science was introduced in teaching children from seven to ten years of age.

Mrs. Talbot thought a recommendation should be made to the Education Department to put forward a rule that the first extra subject in boys' schools should be physiology, just as the first extra subject in girls' schools should be domestic economy. Two extra subjects could be taken in all schools under the Department, and she never heard of French and Latin been taken as had been suggested.

Sir Henry Cole said that they were so taken.

Mrs. Talbot thought possibly a particular reason might exist for that in London just as in Kidderminster, girls were taught drawing, because it would afford them the means of gaining a good and respectable livelihood, their services being much in request by the manufacturers in the town. Certainly no subject could be taken up before domestic economy. One necessity for teaching physiology was the great expense of diagrams, for pictures and text-books, though they enable teachers to satisfy the inspectors, could not bring the matter home to the children. Prizes and certificates might be given for cooking, washing, and other branches of domestic economy, and men would soon learn to look out for the most desirable wives among the young women who held the certificates.

Lady Stanley of Alderley had had a long experience of this kind of teaching, and had as far back as 18 years ago taught a class of girls in the country on physiology, and she remembered the interest they took in the dissection of a sheep by the village butcher, at her instance. She afterwards taught in St. Luke's parish, London, and being unable to obtain animal specimens, she recommended her pupils to notice ligaments and tissues of animal parts exposed in the butchers' shops. She had also taught her children at home, and had in all cases found that children take a great interest in these matters and easily understand them. It was often said that poor children were inferior to those of richer people in intelligence, but it should not be forgotten that they had practical teaching by seeing their mothers handling articles of food, which children in the higher classes never obtained, and she had found children of the lower classes very acute.

Miss Peechey knew something of the slums of London, Edinburgh, and Leeds, and could speak to the intelligence of the working class of children. After marriage, their intelligence toned down by their being kept at home. A rational basis should be given to children for the acts they were to perform, and when proper explanation was given them, they were taught much more rapidly.

Sir Henry Cole considered these subjects should not be taken up as extras, but as primary subjects. The Code was not unchangeable like the laws of the Medes and Persians, and domestic economy might yet find a place in it before reading, writing, and ciphering. He agreed with Miss Peechey that the brightness and intelligence of women of the working classes were affected by marriage, and the tyrant, man, was no doubt responsible for it; but if boys were taught something of these subjects they might do more when men to alleviate the condition of their wives.

Mr. Walther had seen in some of the towns of the Western States, classes taught by means of models, some simple verse being given out for the children to say during each operation they were performing, such as making beds or throwing open windows with the object of impressing the teaching on their memories. Little things learned in that way in youth were remembered in after life, and much good might be done by the publication of small treatises of that character compiled for the use of children.

Mr. Pope said certificates were given by the Society of Arts, and he knew, as a lecturer, how they were striven for in classes. Every one of his ladies in an ambulance class had taken first-class certificates, but he was sorry to say the men had failed disgracefully. In these matters young ladies easily took the first place.

Mr. Edwin Chadwick maintained, as a fundamental axiom, that the home and the child were the chief domain of woman. If the tenour of the papers read by ladies at this Congress of Domestic Economy were fairly considered, it must be admitted that, on the whole, those papers were calculated to extend and vindicate that domain by their advocacy and demonstrations of the useful and the practical, as by living and applied science against the dead languages, and the theoretical and useless too long intruded by scholiasts.

Paper by Miss Louisa Twining, on "The Prevention of Disease," read by **Lord Alfred Churchill.**

Paper read by **Mr. Pope**, "Health in the School-room."

Madame Lofving said it was not sufficient to teach people the principles of domestic economy; they should be taught that they had within their own bodies organs for the performance of physical functions which were in themselves sufficient for the preservation of their health. As far back as 1830 that had been done in Sweden by Dr. Ling, and the State there soon took up the matter as one vital to the common weal. The Swedish military system was based on that gymnastic training, and another branch was medical gymnastics, for the cure and alleviation of injury and disease.

Mr. Chadwick had received testimony from officers in the Swedish Army that, by teaching the boys on Ling's system, it had been found that the period of service could be shortened, and that the actual force of the army had been largely increased. Even the Russians had adopted Ling's system.

Paper by **Mrs. Johnstone** (of Hastings), on "Prevention of Epidemic Disease," was read.

Mr. Chadwick pointed out that the essence of the paper was home treatment of disease where isolation was possible, as in the upper rooms of a house; and the possibility of avoiding contagion was shown by the fact that nurses often succeeded in protecting themselves for 20 years.

Sir Henry Cole said school-rooms ought not to be in so bad a condition as had been described by Mr. Pope, as the inspectors had power to report upon them when not up to standard; but the fault lay in the absence of a system on which to proceed. How imperfectly the inspectors' work was done was shown by the fact that in 1879 they had reported only four schools as teaching cookery, but this Congress had ascertained that there were no less than 300 in which that was done throughout the country. That kind of inspection was a work to which women alone could pay sufficient attention; and the members of the Congress should never rest until the education for home-life, which was the province of women, was provided for before the ologies were taught.

Lady Strangford made a few concluding remarks, and the meeting separated.

At the afternoon meeting, Lady Stanley of Alderley occupied the chair, and the Rev. J. P. Faunthorpe officiated as assessor.

Section D 2.—Thrift.

Paper read by **Lady Stanley of Alderley**, on "The Girls' Home Certified Industrial School."

Paper by Mrs. Townsend, "The Girls' Friendly Society," was read by the **Rev. J. P. Faunthorpe, M.A.**

Paper by **Lady Stuart Hogg**, on "The Metropolitan Association for Befriending Young Servants," was read.

The Rev. J. P. Faunthorpe, in inviting those present to join the Servants' Friendly Society, urged that servants should be encouraged to open accounts in the savings' bank as an important means of bringing about the reforms advocated. One way of inducing children—and possibly through them their parents—to begin to save was the distribution among them of post-office stamp slips.

The Rev. Mr. Long had spent a long time in India, and had had considerable experience in teaching and training women in the East. He had found that the great difficulty was always that insufficient attention was paid to the teaching of domestic subjects. The example of this Congress would not be confined to England, but would extend to the East; and no country more required to have inculcated among the people the principles here put forward than India.

Dr. Mann said that nothing too strong could be said in favour of the Girls' Friendly Society, and assured the members that they would be doing a good work by inducing as many as possible to join it.

Paper read by **Rev. W. L. Blackley**, on "National Teaching of Thrift and Providence."

Mr. G. C. T. Bartley, manager of the National Penny Bank, reminded the Congress that their object was not so much the laying down of principles on which the world was to be reformed, but to show, in a practical way, how children in schools could be taught to be thrifty. One of the best means of doing that was by giving a simple lesson in every school on the Penny Savings Bank, and on the Post-office Stamp Savings Bank. Post-office forms might be kept in schools, and stamps also, on which the children might be induced to expend their half-pence. Thousands would in that way be made thrifty. Children could easily be made to understand the principle of the savings bank, and they would soon begin to feel it a point of honour to have a little account there. That kind of work might be done with great advantage while waiting the arrival of the compulsory system shadowed forth by Mr. Blackley. Waste was a subject which was seldom looked after in schools, and very few teachers or children really understood its effects. Thrift was not necessary for the working classes alone, but for all. Children could easily be shown that waste damaged the person guilty of it and the community alike. Life assurance should also be explained, and could very easily be made intelligible by the teachers. This Congress should not make the mistake of carrying out anybody's special scheme of thrift, but should take care that simple practical instruction upon it was given to children in the schools.

Dr. Mann read a paper on "The Formation of Habits of Temperance among Girls."

Sir Henry Cole, without saying anything about temperance or intemperance, would revert to what was best to be done for teaching thrift in schools. Since 1847, the Education Department had made grants for the purchase of lesson and text-books; but they had in fact lost their soul, had no belief, and, as Sir J. Kay-Shuttleworth had said, "had become a mere red-tape administration of Parliamentary grants, by rigid rules, with the intention, above all things, of preventing the growth of the charge."

Lady Stanley of Alderley could not remain quietly by and hear the department disparaged, knowing how much had been done by it during the last fifty years.

Sir Henry Cole insisted that we had gone back within the last thirty years in our notions of how to teach children to be thrifty, and that result had arrived from our having got rid of all responsibility of advice.

Sir Walter Stirling was glad to see ladies so assiduous in this work, and that they had so efficient a leader as the Lady President. It was hard to expect persons without money to exercise the virtue of thrift. Ladies should have chiefly at heart to teach young girls how to do their duty, and to follow, even in household matters, the golden rule of doing to others as they would be done by.

Mrs. Ross, in reference to the necessity of teaching temperance in schools, gave an instance of an inspector, who, on asking the use of water, failed in a whole school to obtain an answer that it was used to drink. From a medical point of view they should be made acquainted with the fact that the drinking of small quantities of water was beneficial in cases of exhaustion.

Mrs. Charles read a paper on "Food-waste in Workhouses and District Schools."

Dr. Frances Hoggan read a paper on "Advantages of Effective Diet in Workhouses and Prisons."

Mr. Nunn read a few statistics from a report of the committee appointed to inquire into dietaries in the prisons of England and Wales as to the cost of food and the quantities consumed.

Paper by Miss Preusser, on "Boarding out of Pauper Children," was read by **Mr. Tennant.**

Rev. J. P. Faunthorpe (as Assessor) congratulated the members on having had the opportunity of hearing so many valuable papers as had been read, and hoped this would be a good omen that the Domestic Congress, as far as the Section "Thrift" was concerned, would not be wholly fruitless. He referred in complimentary terms to Mr. Blackley's paper, and the practical suggestions made by Mr. Bartley, adding, that the latter gentleman was in error in supposing that this subject was not already taught in schools. Lady Stanley's recommendation that post-office stamp forms should be distributed among the children would be thought particularly valuable, and Dr. Mann's paper on the important subject of temperance, bore closely on the lives and habits of the people. Too much importance could not be attached to the desirability of supporting the Girls' Friendly Society, whose praiseworthy object was that young maid-servants coming from country places to London might find that they were not entirely friendless and alone in the wide waste of the metropolis.

Lady Stanley of Alderley, in addressing to the meeting a few concluding remarks, specially mentioned the name of the late Mr. William Ellis, who had first brought the subject prominently before young people, and had, by his efficient style of teaching, much impressed all he taught.

The Rev. Newton Price proposed a vote of thanks to Lady Stanley for her services in presiding over the Section.

Dr. Mann, in seconding the proposition, called attention to a small work published on the subject by the late Mr. Ellis, for use in schools.

The vote of thanks was passed unanimously, and the meeting terminated.

Friday evening, 24th June, 1881.

Teachers' Meeting.

The Rev. Newton Price, M.A. (presiding), said the managers of the Congress had felt that however important the sentiments might be of ladies and gentlemen more or less connected with the management of schools, and in some cases with the formation of public opinion, it was desirable to ascertain the opinion of the teachers, and to secure their hearty co-operation, the more especially as there was a feeling that some teachers were not altogether so favourable to the cause of teach-

ing domestic economy as might be expected. He personally believed the feeling to be much exaggerated, but no doubt here and there teachers looked upon the subject of teaching domestic economy as derogatory to their dignity. The committee, however, were particularly anxious to elicit the opinions of the teachers in the matter. They desired not to be held responsible for some things which had been said by speakers, and which must have been a little painful to teachers. The future of our country depended to an enormous extent on the way in which teachers did their work, and the good influence they exercised over the children now growing up under their care. They were and would be increasingly the most influential body in this country. The privileged classes, as they were called, were after all but a mere handful, and having the education of the bulk of the people in their hands, the teachers wielded really an enormous influence. The Congress felt quite sure, therefore, that in pressing these subjects upon their attention they would recognise that it was sought to engage them in a work which demanded their fullest sympathy.

Mr. Mostyn Price, one of her Majesty's Inspectors of Schools, read a short paper on his "Experiences in the Examination of Needlework."

Sir Henry Cole said the ladies of the committee had suggested the adoption of the very plan mentioned by Mr. Mostyn Pryce, but though their suggestion had not been received by the educational authorities with the respect it deserved, they were not daunted, and were determined to secure a still more representative exhibition of needlework next year. Possibly the comparative paucity of the attendance at this teachers' meeting was attributable to the fact that domestic economy formed no part of the subjects taught by male teachers, who, therefore, were not perhaps much interested in it. It had been hoped that a relaxation of the severe rules of the Education Department would have enabled many of the inspectors to be present, but he feared that body was not particularly favourable to the object they were pursuing.

Mr. Mostyn Price begged leave to state that, although he was present in his private capacity as an individual, he had been desired by the Department to give the Congress every assistance in his power. Most of the inspectors were far away engaged in their duties throughout the country, and those who were in London, were engaged in extremely hard work at the present time, and to that reason their absence must be attributed.

Sir Henry Cole had been at considerable pains to obtain for the special benefit of the teachers invited to the meeting two specimens of certificates formerly offered to teachers, and endorsed annually by the inspectors with their opinions on the conduct by the holders of the schools in their charge. Upon those certificates the grants were made At present it seemed that the statements of the inspectors were very general, being merely that the condition of the school was good or satisfactory, or had improved, and so on, but saying nothing as to whether the buildings were in proper condition, the discipline efficient, or as to the teaching of the various subjects. He would like to know whether the inspectors did really make a return upon all the points which governed the payment of public money according to the Code. When the education scheme was first started in 1840 by Dr. Kay-Shuttleworth, certificates were granted in the most thorough and formal manner, and signed as was the one he had before him, granted in 1848, by the superior authority over all education, the Lord President himself. Of that thorough description a document should be which affected a man's character and prospects, and, further, it enabled those interested in educational matters to know more about him than did the modern certificate. It certified the amount of knowledge possessed in each of the subjects mentioned in it in the most exhaustive manner.

A Lady inquired to what kind of school the certificate referred?

Sir Henry Cole said it had reference to a national school in the neighbourhood of London. At present the certificates were issued in the most general form, simply of three grades. For the fact that whereas, 40 years ago, teachers had real, genuine certificates given them, by some process altogether unknown those certificates had been turned into the present windy, useless documents; he was puzzled to account, but it was a mystery which he hoped they would get at the bottom of before long. He would ask teachers themselves, in the first place, which form of certificate they preferred; and he certainly thought that if the public were not to be allowed to know what they received for the money expended in training teachers, the sooner the better the system of giving certificates was abolished altogether as a mere fiction.

The Rev. Newton Price was of opinion that the teachers would probably prefer to have their acquirements stated; and there could be no doubt that managers of schools and the general public would also like to have the facts stated for their information.

Miss Guthrie Wright thought the form of certificate giving full particulars was based on the better principle.

Mr. Hugh Clements said that, as a rule, teachers objected to unnecessary interference with their private affairs, and considered that a too elaborate certificate would disclose more than they desired, or it was necessary should be known. Their training at the college was a sufficient guarantee that they had received a good education. On the other hand, they desired to have certificates on particular subjects, such as drawing.

Sir Henry Cole remarked that that certificate was given, not by the Education Department, but by the Science and Art Department.

Mr. Clements continued that teachers complained very much that the grants they now earned were so cut down that it was not worth their while to teach drawing at all. £400,000 a year was paid by the public, and out of that the Science and Art Department expended in grants only some £40,000, the rest being swallowed up in the expenses of administration Teachers often spent their whole day in making up forms, when their time and attention would be much better devoted to their scholars and assistants. Continual alteration was made in the forms sent out to the teachers, and there was really no system followed by the irresponsible members of the School Board.

Rev. Newton Price observed that Mr. Clements was under an entirely wrong impression with regard to the immunities and privileges of the School Board. A very useful question had, however, been started by him, that of making the teachers' payment depend very largely upon results. Personally, he (Mr. Price) had been much opposed to the system for many years, and in the schools with which he was connected it had been entirely got rid of. It had been found that the payment of a lump sum was much more satisfactory to the teacher, whose mind should be left entirely free from monetary anxieties. He certainly considered that teachers' salaries should not be left dependent on the grants.

Mr. Barber, of Cheltenham, one of H.M. Inspectors, protested, in reference to the comparisons made between inspectors, against the notion too commonly held, that when the per-centage at examinations was found to have fallen, that the inspector on that occasion was the wrongdoer. There was no reason whatever why the assumption should be made.

Mr. Stephen Mitchell recognised the difficulty they had to deal with, as to what ought to be done, and he failed to see how it ought to be done, though he had visited schools of cookery, and examined the methods

of teaching. He thought it was especially ladies' work to suggest how the children of the operative classes could be so instructed that they might, as they grew up, be useful to their parents in home matters, and afterwards be better able to provide for husbands and children, by that means bringing up a healthier race of people. As it appeared that no definite resolution was to be passed in the matter, he was afraid that this, like all other Congresses, having led to much talk, would have no practical result whatever.

Mr. Clements thought Congresses were instrumental in changing public opinion. When the people became convinced of the utility of new methods, and desired that they should be put into practice, they soon brought the pressure to bear on the Government for the adoption of the necessary measures. On so important a subject as this they could not have too many Congresses and meetings of all kinds, affecting as it did, the food of the people.

Sir Henry Cole thought the use of Congresses had been unjustly depreciated by Mr. Mitchell, and quoted the opinion of Professor Huxley as to their value, as Government always lagged a little behind public opinion, and Congresses were a most efficient means of pressing them on. He then proceeded to read a list of the teachers who had gained prizes offered by the Society of Arts.

List of Awards of Medals for Papers in the Teaching of Domestic Economy.

1. "The Teaching of Domestic Economy," by Miss E. M. Brant, Board School, Berkhampstead, Herts.
2. "The Itinerant Method of Teaching Domestic Economy in Public Elementary Schools," by William J. Harrison.
3. "How I Teach Sewing," by Miss Jane B. Curry, Episcopal School, Dumbarton.
4. "Instruction in Needlework," by Miss Eliza Jane Allen, St. Mark's Girls' School, Belgrave-gate, Leicester.
5. "Needlework considered under Four Heads," by Miss Sarah A. Hall, National Schools, Beachampton, Bucks.
6. "Some Points considered in Teaching the Second Branch of Domestic Economy," by Miss Harriet Martin, of Whitelands, Chelsea.
7. "How I teach Practical Cookery," by Miss Buncle, Episcopal School, Dumbarton.
8. "Practical Cookery in Elementary Schools," by Miss A. M. Griggs, School of Cookery, 6, Shandwick-place, Edinburgh.

The meeting then adjourned.

Saturday, 25th June, the Countess of Derby in the chair.

Sir Henry Cole read the report of the Executive Committee to the Council of the Society of Arts. [Printed in Council's Report, *ante* p. 653.]

The adoption of the report was moved by **Lady Derby**, and seconded by **Lady Stanley of Alderley.**

Sir Henry Cole said that by agreeing to the substance of the report, the ladies present would add to its force when sent before the Council, with the weight of their adhesion.

The resolution was carried unanimously.

Sir Henry Cole then said the only remaining work for the Congress to do, was to express their approval of the announcement that they should go to the Lords of the Council with such representations on this subject, as would be likely to influence them in making an alteration in the Code. The request, which had been already signed by the Duchess of Leeds, Lady Stanley of Alderley, and other ladies at the Needlework Conference, was as follows:—"The Executive Committee are requested to make arrangements for holding an Exhibition of Plain Needlework, in 1882." That request was to be communicated to my Lords, and, if need be, they would be asked to receive a deputation of ladies, who would express their views.

Mrs. Dacre Craven said she had been informed that it was only proposed to hold the exhibition every five years. Exhibitions of industrial work certainly were held only at intervals of ten years, but in collections of that character it was necessary to exhibit new inventions, and to show that the work was attended to and taught. It had been considered, therefore, that to hold the exhibitions every two or three years would give a greater interest to needlework in the schools, and they were not pledged to five years.

Sir Henry Cole said the request had been signed for a sufficiently authentic exhibition to take place next year. That could only be done effectually through the Department, the whole machinery, and everything else being at the South Kensington Museum. There would be no insuperable objections probably to periodical exhibitions being held if they were desired.

A Lady suggested that it might be useful if the schools were asked to send up reports of what they were now doing.

Sir Henry Cole said that was just what the Congress had engaged to do. They proposed to make the most extensive inquiries, and that would be the first business of the Executive Committee. As the last report of the Education Department had only given half-a-dozen schools where cookery was taught, the Committee thinking it very imperfect, had drawn up a set of questions on the point, which they had been permitted by the Education Department to send to the inspectors of schools, and the result showed that in more than 300 instances cookery was taught. A most interesting amount of information besides, which had never come before Parliament, would be published in a few days in the document they had prepared. He concluded by proposing a vote of thanks to Lady Derby, which was passed unanimously, as was a similar vote to Miss Webb, for her services to the Congress.

Sir Henry Cole, before declaring the Congress for this year at an end, was desired by the Lady President to say that it had not been from want of interest in its objects that she had not previously attended, and in confirmation of that statement he would remark that she had, in another practical way, shown her desire to assist in the carrying on of these Congresses.

The Congress was then declared at an end.

MISCELLANEOUS.

SECONDARY BATTERIES.

The following description of the Planté and the Faure secondary batteries is taken from the *Electrician*, the editor of which paper has kindly lent the blocks (from *La Lumière Electrique*) to illustrate it. Figs. 1 and 2 (p. 687) represent the Planté cell.

The preparation is as follows:—Two sheets of lead are laid the one on the other, separated by two strips of india-rubber, the whole being rolled up as shown in Fig. 1. The roll having been completed, the cylinder used in its formation is withdrawn, and it is consolidated by a wrapper of gutta-percha, and inserted in a glass jar filled with water, and 1-10th part acid. An electric current is then made to pass through the cell, oxygen is given off and produces a thick cushion of peroxide of lead in one sheet; hydrogen is

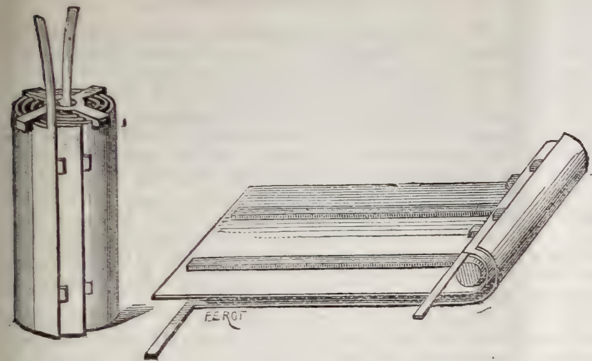

Fig. 1.

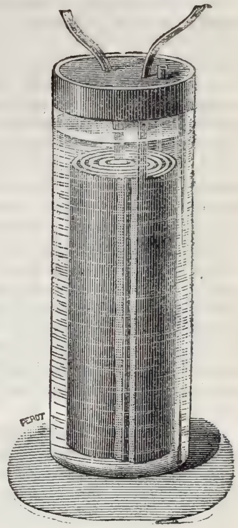

Fig. 2.

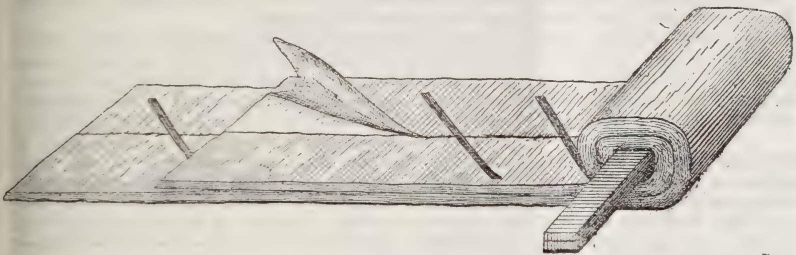

Fig. 3.

given off at the other sheet. If the current with which the cell has been charged be cut off, and the two sheets are connected, a current will be produced owing to the

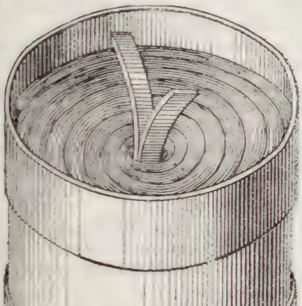

Fig. 4.

presence of the oxygen, which leaves the sheet where it has accumulated and attacks and oxidises the other sheet. This secondary current, which is very small at first, gains strength each time the operation is repeated; in course of time the surfaces of the sheets are changed, the one being covered with a cushion of peroxide of lead, the other with lead reduced to a spongy mass. The cell is now complete, and in a state of electrical accumulation.

Subsequently, M. Planté tried the plan of separating the two sheets of lead by canvas, the cell taking the form of Fig. 2. He next found that it was necessary to leave a small space between the sheets to provide for the escape of the gases which were produced at the end of the charge; subsequently, india-rubber bands were employed in preference to canvas. M. Planté also tried carbonate of lead, minium, &c., but without improving upon the results already obtained.

The Faure battery is very similar to the above, and is constructed thus:—Two sheets of lead are taken, 0·20m. large, the one about 0·60m. long and 0·001 thick, the other 0·40m. long and 0·0005m. thick. Each of these is furnished with a strong strip of lead at one of its ends. Each sheet has a layer of red lead spread on its surface, the lead being made into a paste with water, the larger sheet having about 800 grammes on its surface, and the smaller 700 grammes. On each surface a sheet of parchment is laid, and the whole is introduced into a sheathing of thick felt. The sheets are laid one above the other; at the same time several bands of india-rubber are placed in an oblique fashion, as shown in Fig 3. The roll is placed in a leaden jar, strengthened by copper bands, and supplied in the interior with red lead and felt. The cell then presents the appearance shown in Fig 4. One of the pieces of lead which jut out is curved and soldered to the outer jar, acidulated water is put in, and the battery is ready for work.

Some experiments with an extemporised Faure battery have been carried out recently in the office of the *Scientific American*, which are described as follows:—"In attempting to follow M. Faure's plan of construction, some

difficulty was experienced in making the red lead remain in place during the rolling up of the two electrodes. Therefore, the battery was constructed of square plates of lead, each having an ear projecting upward from one side, for attachment to a binding post. This plan succeeded very well, the flat plates having the advantage of retaining a great quantity of red lead and of being easily formed into a compact pile. The plates employed were of pure lead foil, having the thickness of a post-card, a width of 7 inches, a height of $7\frac{1}{8}$ inches, with an ear projecting from the top $1\frac{1}{2}$ inch wide and 3 inches high. The total effective surface on both sides and edges of each plate was 100 square inches. Ten such plates were sufficient for a single element for ordinary uses, and such an element may be fairly charged by means of four gravity cells, but a stronger current is much quicker and more satisfactory. The method followed in building up these secondary elements was as follows:—After cutting out a sufficient number of lead plates, pieces of canton flannel, 15 inches long and $7\frac{1}{2}$ inches wide, were cut; and, finally, as many sheets of blotting paper, $7\frac{1}{2}$ inches square, as there were lead pipes, were provided. The next step was to prepare a thick paint of red lead by mixing the dry pigment with water containing one-tenth of sulphuric acid. This paint had a consistency of paste, and was applied thickly to one side of the sheet of lead with a common flat paint brush.

The canton flannel having been painted to within one-quarter inch of all its edges on the nap side, the lead was laid, painted side down upon the painted canton flannel, when the other side of the lead was painted, and the cloth was neatly folded over the lead, completely enveloping it with the exception of the ear at the top, and projecting about one quarter inch beyond all the edges of the lead. The lead with its envelope was then laid upon a level board, and another plate was prepared in the same manner and placed over the first, with an intervening layer of blotting paper, and with the ear placed opposite the ear of the first. Other lead plates were added in the same way, with the interposed sheet of blotting paper, and with the ears alternating in position. When ten plates had been placed together in this manner they were clamped together with two or three elastic bands, and the ears were brought together and passed through a slit in the wooden cover of the containing cell and bent down upon the top of the cover. They were then pierced and traversed by the screw of a binding post which entered the wood. In this way each pole of the element was furnished with a binding post, and at the same time firmly secured to the cover. The cell was then partly or wholly filled with acidulated water—water 10 parts, sulphuric acid 1 part—and after the cloth and blotting paper had become saturated the element was connected with four gravity cells. In one hour the element had stored electricity sufficient to heat $1\frac{1}{2}$ inch of fine platinum wire to redness, to work a magnet strongly, and to run at a high rate of speed for fifteen minutes a small electric motor that requires at least ten gravity cells to operate it. After this preliminary experiment a number of the new secondary elements were prepared in the same way and charged separately with a dynamo-electro machine. One element of ten plates, after receiving the current from the dynamo for ten minutes, operated the small motor above referred to, for something over three hours. Another ten minutes' application of the current from the dynamo charged it so that after eighteen hours of rest it yielded a current which seemed as strong as when it was first charged on the previous day; but a time test proved that it was incapable of running the motor for quite so long a time as when the current is used soon after storing."

The Faure battery was exhibited for the first time in England at the *Conversazione* at King's College, on Saturday, 2nd inst., when it was used to light the Swan and Lane-Fox electric lamps.

PLANTAIN TREE.

Mr. L. Liotard has prepared an elaborate memorandum on the plantain tree (dated Calcutta, January 22, 1881), of which the following is an abstract:—

Dr. Balfour, in a note dated the 15th October, 1880, has noticed the Agricultural Department departmental memorandum on fibrous materials in India suitable for the manufacture of paper; and he specially directs attention to the chapter on the plaintain tree. Many species of this tree, or rather, plant, have been grown in India from the most remote times; but as a producer of marketable fibre, the only species which has yet come to note is the *Musa textilis* of the Philippine Islands: this yields the fibre known in commerce as Manila hemp.

The introduction of the *Musa textilis*, in 1858, direct from the Philippine Islands into the Madras Presidency, is described in the printed memorandum, where it is shown that attempts made to extract the fibre in this country for commercial purposes proved fruitless, although thousands of tons of it were being extracted every year in the Philippines.

There is no doubt that the Manila hemp plant (*Musa textilis*) grows as well in British India as other species of the plaintain genus; and Dr. Balfour justly says, that British India could in a couple of years supply the London market with all that it could take of Manila hemp fibre. He therefore observes that the prospect of benefiting British India by creating an export trade from it of the extent and value above indicated might well incite to considerable efforts to attain success; and he suggests that the attention of the Boards and Commissioners of Revenue, and of the Agri-Horticultural Societies might be re-directed to this plant.

It is known that the *Musa textilis* was reared with success in Calcutta as an experiment in 1822, 1836, and 1840; that fibre was extracted from the plants and made into a neat cord no way inferior to English whip cord; and that a project was then put forward for the establishment of the manufacture of paper from the fibre; but we do not know how or why the project was not carried out. The projector, we learned, went to one of the British colonies in South America.

We know also that in the Madras Presidency the efforts to introduce the *Musa textilis* were of a more extended nature, beginning from 1858; that the trial planting proved very successful; that numbers of the plant were introduced and reared; that the fibres extracted therefrom were cleaned and experimented upon and were found to possess considerable strength and gloss; to be very clean, and fit for taking dyes; also that success in the rearing of the plant was especially attained in the Wynaad, where it grew remarkably well and was multiplied in large numbers in several of the coffee estates both easily and cheaply; and that there was no doubt as to the value of the fibre, but that the efficient and cheap preparation of the fibre remained an unsurmountable difficulty.

In the Andaman Island also the plant was successfully reared and propogated, and fibre was extracted but the process of extraction, which consisted in steeping the stem until decomposition set in, was probably a very bad one, and consequently the fibre which was reported to be creditable in other respects was found harsh and wanting in strength.

The experience gathered thus seems to point to the discovery of some satisfactory process for extracting the fibre cheaply and efficiently as the essential preliminary to any extensive Indian trade in the product. The mode of treatment followed in the Philippines may first be noted; the British Consul at Manila explained it as follows:—

"When the trees have matured, or are ready for cutting, they are cut down about a foot from the ground; and the labourer then proceeds to strip off the layers from the trunk, which are cut into strips

bout 3 inches wide, or say, three strips to each ayer. These strips are then each drawn through etween a blunt knife and a board to remove the ulpy vegetable matter from the fibre, which is then pread in the sun to dry. As soon as it has been horoughly dried, it is ready for the market. The ppearance of the fibre depends entirely on the care estowed in drying it, as, should it be exposed to rain, r not thorougly dried, it becomes discoloured, or ssumes a brownish tinge, and loses the strength to ome extent.

* * * * *

"As regards machinery, several attempts have been nade, but have proved unsuccessful, to invent a suitble machinery for cleaning, to supersede the primiive method still in use, which consists of a few cross nd upright bars of bamboos, to which are fastened the oard and cleaning knife, the fibre, or rather, the ayer of strips, being introduced between the board and he knife, which latter is then held down by a string ttached to a cross bamboo, on which the foot of the orkman is placed, and the strip is pulled through, hus removing all the vegetable matter."

The annual quantity of Manila hemp which is exracted by this means in the Philippines is reported to e about 40,000 tons, of which the United Kingdom akes about half.

Whether any improved method of extracting the bre be or be not discoverable, there does not appear to e any reason why the method of extraction followed n the Philippine Islands should not be adopted in British India, with any modifications which experience nay suggest.

I have myself tried an experimental process, in deising which I was guided by the considerations below xplained.

The first of these was the structure of the plant. It s composed of layers of fibre united together longiudinally by cellular tissues which contain a very large er-centage of mucilaginous and pulpy matter in which strong colouring matter is present. There are in the ayers of the trunk three distinct qualities of fibre—it s coarse and strong in the outer layers, fine and silky n the interior, and of a midling quality in the internediate layers, while the central foot-stalk contains no ibre at all. The mid-rib of the leaves also contain trong fibre.

Secondly, the proper time for extracting the fibre. This is of importance if the fibre is ultimately to be sed for cordage or textile manufactures, but of less onsequence, perhaps, if the fibre be destined for aper-making. The proper time is when the purple ruit-stalk is about to rise, but has not quite appeared et; it is then that the fibres are in their best condiion: before that, the fibres will be immature, after hat, they will have lost their strength.

Thirdly, the appearance of the fibre. All fibre is alued according to the degree of its cleanness, its enacity, and its uniform structure; and if, in addition o these three qualities, the fibre is of fine texture, it vill command a high price. It is thus necessary to lassify the fibres. The easiest way to do this is, after he plant is cut down, to strip layer after layer from he trunk, each strip being about two inches wide, and o group the layers according to the fibres they contain, which will be found to present the features above noticed. The stripping is very easily effected by the hand with the help of a knife, and has the advantages of both securing uniformity in the fibres by classificaion, and of facilitating their extraction, as will preently be explained. The mid-rib of the leaves should e slit into four parts to facilitate the crushing, and hould be kept apart from the produce of the trunk.

Fourthly, the time taken in the operations. The uttings should be utilised on the day on which they are nade, and they should be manipulated in the shade. The reasons are that if the fibre be not forthwith extracted, the fleshy or sappy compounds, if subject to wet, will decompose; whilst if they are exposed to the action of the sun's rays. the fibre will be discoloured. Further, the immediate removal of all extraneous matter reduces the bulk of the product, and thus decreases the cost of transport to storage centres.

Looking to the benefit that will result to the country, should success be attained, and the very small expense that will in any case be required, the Government of India may perhaps be disposed to give this process some effective trial in some convenient localities. If so, it might be well to make a beginning in the Wynaad, where the true *Musa textilis* has been successfully introduced and propagated, and where, I believe, large numbers of the plants exist.

A further suggestion which I would venture to make is, that experiments should be made with some of the native varieties of the plantain tree, those varieties being preferred which grow on hilly land, as these contain more fibre than the varieties on low-lying flat ground which are valuable in other respects. Thus, in the Governments of the North-Western Provinces and the Punjab, trial might be made with the species of the plantain trees that grow on the lower ranges of the Himalayas, that is, below Mussoorie, in the lower tracts of the Nahun State, in the Umballa district, and in Kangra. It is just the species that produces insipid fruit, sometimes with seed inside, that will be found to yield a larger per-centage of fibre.

In Bengal, Bombay, British Burma, and the Central Provinces the indigenous species growing on the high lands might usefully be experimented with, the above remarks giving an idea of the kind of plants to be selected.

The real obstacle, however, to the successful introduction of new fibre materials into our export trade is the cost of railway fare. On this point I will reproduce here the remarks which I made in the memorandum I referred to at the beginning of this note:—

"The cost of the carriage, not only of fibres, but of all raw and natural products of India, from the internal districts to large centres of population and to export marts, prevents such products from being utilised, and a large source of income to the country is thus neglected. We find that Mr. Rendell, in his evidence before a Parliamentary Committee, stated that the cost of carrying a ton of goods for a mile is, on the East Indian Railway line, ·218d., and the average cost on nine lines ·376d., or $\frac{3}{8}$ths of a penny. Before long, he says, the cost on the East Indian Railway of carrying a passenger, or a ton of goods, for a mile will not exceed $\frac{1}{10}$th of a penny or $\frac{1}{6}$th of a penny respectively; and though that rate may not be attainable on lines less favourably situated as to fuel, gradients, and quantity of traffic, the cost of transport ought not in any case to exceed $\frac{1}{4}$d. per ton per mile, and $\frac{1}{8}$d. per passenger per mile. 'Experience,' Mr. Rendell said, 'shows that a reduction of rates, especially for passengers and cereals, is always accompanied by a large increase of traffic.' He added that, as consulting engineer of the East Indian Railway and States Railways, he would strongly advocate a reduction of rates, and he was certain that such a policy would ultimately prove remunerative. There can be little doubt that, as regards fibres also, the same beneficial results will be produced by a reduction in the rates."

The Bombay Chamber of Commerce, in a letter addressed on the 9th May, 1879, to the Famine Commission, said :—

"The high rates charged for the conveyance of goods have prevented Western India from reaping all the benefits which were reasonably expected to flow from the introduction of the Great Indian Peninsula system into this Presidency. This statement is borne out by the fact, that on a recent occasion, when a reduction of their grain rates was made, a very large development of traffic immediately occurred and has steadily progressed. In September, 1875, the Great Indian Peninsula Rail-

way reduced their grain rates from the producing districts in the Central Provinces of $5\frac{1}{2}$ pies per ton per mile, being a reduction of 30 per cent. on their previous rates. This reduction left the rates still considerably higher than the East Indian Railway Company's rates, but it led at once to a very great increase in the traffic."

The Bombay Chamber of Commerce then went on to quote figures of exports in illustration of the rapid increase in the traffic, and added:—

"But these illustrations of the effect of reduced rates prove that even railways in India may be of little avail in fully developing the resources of the country if the rates for the carriage of produce are not reduced to the low scale necessary to attract the produce of the districts through which they pass."

There can, therefore, be no doubt that a reduction in the rates of railway carriage for the fibrous, as well as other, products of India would have a beneficial result.

I venture now to suggest that the question be referred to the Public Works Department for early consideration. If a reduction of rates for all fibrous materials is not feasible at present, I would earnestly suggest that such materials, when destined for paper manufacture at least, be allowed to be carried over the railways at rates lower than those now imposed. A gentleman who is engaged in the business in Lower Bengal writes to me on this subject as follows:—

"A great deal of raw material, which could be utilised for paper-making, cannot be brought down by rail on account of the high freight payable according to the present goods tariff of all railways in India.

"Amongst the well-known materials used for paper-making, take, for example, aloe-fibre, jute, hemp, flax, rags, and waste papers; all these, when loosely packed, are at present put in Class 2, the rate of which is 50 pies per 100 maunds per mile. Mounj or any other grass or plaintain leaves, when loosely packed, belong to class 3, and are charged $66\frac{2}{3}$ pie per 100 maunds per mile. Plantain leaves and grass have an additional obstacle in being subjected to a minimum weight of 81 maunds.

"Now, you are well aware that aloe-fibre, jute, hemp, flax, when destined for twine or textile manufactures, might be able to bear a second-class rate on account of their higher market value; but, seeing that it is only the cuttings or waste of these materials that are used for paper manufacture, they cannot possibly be of so high a value, and cannot, therefore, bear the same charge. The cuttings or waste should consequently be treated specially and charged a much lower rate."

This can, I venture to think, be done by placing all materials destined for paper manufacture under a distinct head of "paper-making materials" in the goods tariff, and classing the head under Class I. (*i.e.*, $33\frac{1}{3}$ pie per 100 maunds per mile) when the material is loosely packed, and under special class when despatched, pressed or screwed in bales. In neither case need there be any restriction as to minimum weight, and the usual reduction might be allowed when carried over 150 and 300 miles respectively.

CHINESE MATTING.

The following remarks from a paper by Dr. Hance, of Hong Kong, published in vol. viii. of the *Journal of Botany, British and Foreign*, are supplementary to the article in the *Journal of the Society of Arts* of May 27th, p. 595. The plant used for sails of native craft, or for covering boxes, and described in the United States Consul's report as an "aquatic grass" or "rush," is a cyperaceous plant, known to botanists as *Lepironia mucronata*, Rich. It is recorded as a native of the Indian Archipelago, Australia, and Madagascar. Of the matting made from this plant, Dr. Hance says the natural colour is a pale brown, nor is he aware that it is ever dyed, nor, so far as he knows, is it ever "exported to foreign countries, except, doubtless, in the form of bed mats for Chinese residing in Australia and California. It is certainly remarkable that a plant of comparatively limited geographical distribution, and in none other apparently of its native localities turned to any account, should furnish the raw material for a vast manufacturing industry and, perhaps, still more strange, that the source of this should not before have been discovered. As in the case of *Hydropyrum latifolium*, Griseb., which supplies thousands of tons of a favourite vegetable, it shows how much we may have still to learn, even at the oldest and most frequented marts of trade, concerning the uses to which many apparently insignificant plants are put. The attention of the authorities in our possessions in the Straits of Malacca, and of those of Netherlands (India) might be advantageously directed to encouraging the cultivation of this plant, and so developing a large and profitable manufacture."

Regarding the floor matting, which forms such an important trade with America that it ranks in point of value about sixth or seventh of all articles shipped to foreign countries from Canton, the whole of this matting is woven from the culms of *Cyperus tegetiformis* Roxb. It does not seem to be known what the "hui-fà" plant is, from the flowers and seeds of which a yellow dye is prepared, but Dr. Hance is of opinion that the "lam-yip," or blue plant, is referable to the natural order "Acanthaceæ."

From a table showing the export of matting from the port of Canton from 1870 to 1877 inclusive, it seems that, next to North America, Hong Kong takes the largest quantity, Great Britain taking third. During the years as stated above the largest quantity was exported in 1872, when 115,220 rolls were sent away.

CORRESPONDENCE.

DOMESTIC ECONOMY CONGRESS.

By an error in the report of a previous meeting (p. 638) I was made to point to the educational administration of St. Pancras as a model for imitation. On the contrary, I pointed out the educational administration of the district half-time school of Anerley as the model for the study of St. Pancras, so far, as appeared, and of other parishes.

EDWIN CHADWICK.

GENERAL NOTES.

Portable Disinfector.—The principle adopted in this dininfector, by Mr. Washington Lyon, is the introduction of steam, under regulated pressure, into a specially-constructed apparatus, in place of dry heat, for the purpose of destroying all forms of insect life and the lower organisms germs, &c. The chief advantages claimed for the apparatus are that, while all kinds of wearing apparel, bedding, furniture, &c., can be disinfected by its means, no article need be unmade, the colours of silk, woollen, and cotton materials are unaffected, papers are uninjured, and all unpleasant smell is avoided. The apparatus is made of iron, having an outer casing, with a space between, into which steam, at a pressure of about 25 lbs. is admitted. The articles to be disinfected are placed in the interior, and the door is closed. Steam, at a pressure of about 20 lbs., is then admitted into the interior, which raises the temperature to about 259° Fahr., and the process of disinfection commences. The presence of the steam in the casing prevents condensation of the steam in the chamber. A working model of this disinfector was exhibited last year at the Society of Arts, during the meeting of the Conference on the Progress of Public Health, and it has since been brought into practical use.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, is now open daily. A non-transferable season ticket will be sent to any member of the Society on application to the Secretary. A ticket, to admit two persons, is sent with the present *Journal*.

PROCEEDINGS OF THE SOCIETY.

PLANT LABEL COMMITTEE.

COMMITTEE.—George F. Wilson, F.R.S. (Chairman), F. J. Bramwell, F.R.S. (Chairman of the Council), Lord Alfred S. Churchill, Rev. H. Harpur Crewe, Professor W. T. Thiselton Dyer, F.R.S., Rev. H. N. Ellacombe, H. J. Elwes, Sir Joseph D. Hooker, K.C.S.I., C.B., F.R.S., Whitehead Jeffrey, George C. Joad, Rev. J. G. Nelson, William Sowerby, Rev. Charles Wolley Dod, and Colonel Trevor Clarke.

The following is the Report of the Committee, which has been adopted by the Council:—

The conditions under which the Society's Silver Medal and the £5 prize, provided by Mr. G. F Wilson, were offered, were as follows:—

"The Council of the Society of Arts are prepared to award a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants. The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award. The award will be made on the recommendation of the committee, which will be appointed for the purpose by the Council. Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society not later than the 1st May, 1881. The Council reserve to themselves the right of withholding the medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving."

In answer to this notice, which was first issued in January last, 120 sets of specimen labels were sent in. Some of these are ingenious, but many show ignorance of the conditions to which labels are exposed in open borders, rock-work, &c. There are a great number of applications of glass to labels; some of these specimens were broken even in the transit, showing how unsuitable they are to stand rough usage. Some very useful labels have been sent in, which, though perhaps not absolutely new, are unknown to the generality of cultivators.

The committee are of opinion that none of the labels sent in competition are deserving of the Society's medal, but they have pleasure in expressing their opinion that the following possess many points of merit, and they therefore beg leave to draw the attention of persons interested in the subject to them:—

E. J. Alment, 194, Romford-road, Stratford.—Zinc labels, with galvanised iron wire stems.

J. Pinches, 27, Oxenden-street, S.W. — Zinc labels, with stems of zinc, iron, and oxidised iron.

Thomas Johnston, Saw Mills, Renfrew, Scotland.—Labels of teak wood.

J. Wolstenholme and Son, Grimes-street, Mill-street, Ancoats, Manchester. — Holly-wood and box-wood labels.

Rev. H. Ewbank, St. John's, Ryde, Isle of Wight.—Wood labels, with iron wire supports. These are painted white, and a coat of black paint added, which, when wet, is removed where the letters are required, in order to show the white ground beneath.

J. Wood, Woodville, the Spring, Kirkstall, Yorks.—Zinc labels, with galvanised iron wire supports.

Walter J. Todd, 32, Angell-road, Brixton, S.W. —Wood labels, with wire supports.

C. Yates, Mortlake. — Zinc labels of various patterns; ink for writing on same.

S. Mount, Harbledown, Canterbury.—Painted iron labels.

J. C. Turner, Salisbury-road, Blandford.—Zinc labels.

J. Dowdney, 1, Montpellier-villas, West-street, Croydon.—Wood labels, with wire supports.

Rev. C. Wolley Dod.—Iron and wood labels.

There is also an iron label sent in by the Rev. H. N. Ellacombe, for the inspection of the committee, though not in competition, which is well deserving of notice, since it has been in use for more than sixty years in Mr. Ellacombe's garden, and is still in perfectly sound and good condition.

The committee would suggest that the proprietors of the labels sent in should present their specimens to the Council of the Royal Horticultural Society, if that society is willing to accept them, in order that they may form a permanent exhibition of labels. They also recommend that the offer of the prizes should be renewed for the following year, and for the guidance of future competitors they offer a few suggestions.

Wood is probably the cheapest and best material for cheap labels. It is at present liable to the

objections that the part in the ground rots, and the writing on the label becomes illegible. If by some process, such as perfect kyanizing or treatment with paraffin, these objections could be removed, an excellent cheap label would be the result. Such labels, however, would have to be tested in actual use against unprepared labels, before any award upon them could be made, Slate labels, made thick enough not to break. might be useful. Cheap thick glass labels might be useful for the same purpose, if proper means of writing upon them were provided.

H. Trueman Wood,
Secretary.

CANTOR LECTURES.

WATCHMAKING,

By Edward Rigg, M.A.

Lecture II.—Delivered Monday, Feb. 14, 1881.

Degree of accuracy required in the ordinary watch—Fourteen years' statistics of the clock and watch trade—Systems of manufacture in this country and abroad—Description of specimens illustrative of the various stages of construction—Comparison of the several systems.—Suggestions.

The latter portion of the last lecture was devoted to the consideration of certain points connected with the manufacture and adjustment of high-class watches. I endeavoured to show that, although it may be quite possible to produce a going-barrel watch that shall indicate strictly accurate time at any period through the 24 hours, the care required in the adjustment of so perfect a timekeeper is far greater than when a fusee is employed, for the variation in the force of the best going-barrel springs will cause the arc of vibration to fall off to the extent of about 100°, an amount which represents a very severe tax on the isochronism of the balance-spring. As the delicacy of the instrument may be considered to be in proportion to the care required in its adjustment, it is difficult to see what valid reason can be urged against the fusee in such watches as we are considering. By securing a motive force that is approximately uniform, it very materially diminishes the labour involved in the production of a timekeeper that can be relied on to be accurate throughout the whole day, and, therefore, may be said to actually reduce the cost of manufacture of the best English watch, at the same time increasing its reliability.

But, after all, it is not every buyer that requires such an exact instrument; and the table given at the end of the last lecture seems to show that, for ordinary use, the going-barrel watch has been the subject of very marked advance in recent years. Formerly, when the English and Swiss makers had the entire trade of the world practically in their own hands, and while the English fusee watch was celebrated as a high-class timekeeper, the Swiss going-barrel had complete control of the cheaper markets. But since about the middle of the present century the production of France has very largely increased, and more recently American manufacturers have appeared as competitors, both in their own country and in Europe. This rapid increase in total production, and the improvements in the going-barrel, point to the conclusion that English makers should examine most minutely into their system of working, carefully study the merits of every suggested improvement, and themselves take the watch in hand, investigating any weak points in its design or system of manufacture.

That there is urgent need for such exertions at the present day, especially in regard to the medium and cheaper class of watch, is, I believe, generally admitted, and I have been at some pains to collect such statistical information as might enable us to see how far the growth of foreign competition during recent years is real: the returns suffice to show that the English watch trade is, in a sense, in a more hopeful condition than some would have us believe, notwithstanding that it cannot be said to exhibit any marked signs of growth.

They cover a period of fourteen years, namely, from 1867 to 1880, and are comprised in six tables. Some of the information has been already published, but only a very small proportion of that here given, and never in a collected form. Thus certain hall-marking returns are annually made public, but many of the figures in Table VI. are new, having been expressly supplied to me by the authorities of the Assay Offices at Birmingham, Chester, and London, to whom I would here express my thanks. The fulness of the returns of imports and exports, as compared with those hitherto accessible, may be gathered from the fact that these latter have consisted only of (1) total annual imports of clocks in number and value, and (2) total annual imports of watches in sterling value. These constitute columns 14, 15, and 20 of Table I. Exports have been entirely ignored, as also the details in regard to imports. I should mention that this oversight has evidently arisen from the fact that only the Monthly Statements and Annual Abstracts of the trade of the United Kingdom, published by the Board of Trade, have been consulted; whereas it is only the "Annual Statement" of the same Department that contains the full information.

It would be impossible, within moderate space, to discuss these returns fully; an attentive examination of the figures will be well repaid, as it will bring to light many points of interest, the importance of which one individual may be in a better position to appreciate than another. I propose, however, to add a few notes to each table, drawing attention to its most prominent features.

Table I.—The superior quality of the clocks imported from France is made very evident by dividing the value (which, I may here mention, means "declared value") by the number under each country. Thus, taking the year 1879—

A clock from	Belgium*	is valued at	£0·43
,,	France	,,	3·27
,,	Germany	,,	1·28
,,	Holland	,,	0·27
,,	United States	,,	0·36

Our imports of these cheaper clocks are increasing at a rapid pace, whereas those from France remain stationary. This fact is brought into prominence by the column headed "mean price." The numbers of clocks from the United States and Holland are nearly identical.

* It should be noticed that where Belgium is mentioned in regard to imports, it may taken to mean Swiss manufactures shipped at Belgian ports. Similarly, Holland exports the manufactures of the Black Forest.

I.—Imports.

Year.	Clocks from															Watches from				Total Value of Imports.	Net Imports.			
	Belgium.		France.		Germany.		Holland.		United States.		Other Countries.		Total.		Mean Price.	Belgium.	France.	Other Countries.	Total.		Clocks.		Watches.	Total.
	Nos.	Value.	Nos.	Value.	Nos.	Value.	Nos.	Value.	Nos.	Value.	Nos.	Value.	Nos.	Value.							Nos.	Value.		
		£		£		£		£		£		£		£		£	£	£	£	£		£	£	£
1867	...	...	88,861	198,136	...	...	37,505	9,911	123,800	52,247	1,189	2,994	251,355	263,291	1·048	8,248	178,040	2,895	189,183	452,474	240,983	257,448	185,892	443,340
1868	...	...	94,313	215,310	...	...	29,243	8,963	111,741	48,611	2,916	1,474	241,246	277,358	1·150	8,664	183,677	6,515	198,856	476,214	235,419	269,396	195,341	464,737
1869	...	...	133,196	224,624	1,478	2,492	24,850	10,603	170,405	79,569	483	1,720	330,412	319,008	0·965	14,162	183,057	1,988	199,207	518,215	322,762	311,995	196,093	508,058
1870	...	...	92,348	181,517	1,227	3,069	17,156	8,884	143,973	62,780	2,157	2,378	256,861	258,628	1·007	221,723	128,318	22,379	372,420	631,048	244,737	249,174	343,163	592,337
1871	2,311	3,923	91,474	269,380	4,500	5,842	28,882	18,711	198,174	75,266	166	312	325,507	373,434	1·147	434,386	24,486	10,542	469,414	842,848	368,992	360,970	409,514	770,484
1872	2,096	2,788	123,898	327,711	3,884	4,292	46,069	27,230	198,214	75,619	80	391	374,241	438,031	1·170	270,496	77,312	3,391	351,199	789,230	348,773	417,227	342,467	759,694
1873	5,608	3,522	102,018	302,106	3,700	4,827	51,566	25,364	242,693	92,023	37	186	405,622	428,028	1·055	331,421	67,276	8,586	407,283	835,311	385,797	408,945	400,804	809,749
1874	5.077	4,281	92,574	271,459	3,870	6,430	52,788	16,768	266,374	101,524	173	250	420.856	400,712	0·952	425,073	43,566	5,480	474,119	874,831	395,735	380,218	470,177	850,395
1875	7,974	5,684	96,897	254,886	5,155	9,669	123,749	27,452	285,028	107,029	10	76	518,813	404,796	0·780	409,652	37,056	4,489	451,197	855,993	490,903	383,820	443,718	827,538
1876	39,750	13,610	101,031	281,022	6,245	9,235	188,168	41,337	265,818	98,651	17	100	601,029	446,955	0·744	414,951	27,618	7,498	450,067	897,022	556,571	417,411	430,670	848,081
1877	42,124	15,391	101,487	314,325	7,242	10,016	239,687	65,283	296,542	107,780	189	592	687,271	513,387	0·747	484,573	16,636	2,955	504,164	1,017,551	635,644	486,276	480,121	966,397
1878	17,961	6,863	100,136	357,605	6,080	9,177	313,448	86,925	294,453	101,049	1,944	973	734,022	561,592	0·765	496,042	11,393	5,033	512,468	1,074,060	677,228	531,962	481,868	1,013,830
1879	13,394	5,761	92,545	303,816	5,299	6,787	342,491	93,127	376,023	133,856	164	94	829,916	543,441	0·655	435,357	7,702	15,529	458,588	1,002,029	760,683	505,101	428,243	930,113
1880	23,473	8,067	92,747	285,950	10,862	11,609	336,929	95,314	405,897	153,815	121	263	870,029	555,018	0·638	415,028	6,205	6,430	427,663	982,681	719,811	481,522	401,646	883,168

In regard to imported watches, there are several noticeable facts. Since 1870, the beginning of the Franco-German war, Swiss watches have come to this country by way of Belgium instead of through France; indeed, the tariffs imposed by the French Government are so prohibitive, that the great majority of the French watches pass into Switzerland, and are then exported to England by the same route. Under "Other Countries," in 1880, are included watches to the value of £2,115 from Holland, and £2,197 from the Channel Islands.

The American watch trade does not figure in the returns, for imports from "Other Countries" only amount to about £5,000 per annum. 1876 was the only year in which America was specified, when the amount recorded was £4,272 (and this I have included with the amount given for "Other Countries"). The relatively large figure in 1879 comprises £13,933 from Holland; and thus the returns, full as they are, must be regarded as deficient in this important particular. The omission appeared to me to be so serious that I consulted Messrs. Robbins and Appleton with a view to its explanation, and they have obligingly given me, for publication, the number and value of their imports into this country during last year. The "movements" imports numbered 24,330, and the approximate value was £40,000; the reason for the omission from the official returns appears to be that the watches are all without cases, and are therefore classed at the Custom-house as "watch materials." These figures will enable us to apply an approximate correction to the total imports for the previous years.

The section headed "Net Imports" is deduced from the total imports by deducting the exports of foreign produce shown in Table IV.; the figures thus obtained, together with the American watches imported, must be taken to represent the annual home consumption of foreign-made clocks and watches. They show a rapid growth in the number of clocks, and a somewhat irregular but distinct growth in the value of watches; the net imports during the year 1880 are, however, in both cases, somewhat below those of the year that immediately precede it.

Table II.—The first column of Table IV. gives the gross annual value of the exports of home produce, classed as "Clocks, Watches, and parts thereof." I thought it advisable to include all the information supplied by the Government Returns, and have therefore prepared this Table II. It is, however, in a sense unsatisfactory, owing to the fact that in many instances different countries were specified from year to year as importing the manufactures of Great Britain; but since 1871 there has been a greater degree of uniformity, although the subdivision is less complete; nevertheless, the table is in a high degree interesting, as showing who are our best customers, but it does not call for much special remark. The £20,038 sent to "Other Countries" in 1881 includes £2,187 in exports to Germany.

The statistics prior to 1870 are singularly complete, as clocks and watches are given separately both by number and value. Comparing the line of totals at the bottom of the table with the first column in Table IV., it appears that about 60 per cent. of the exports are watches, the mean price of which fell gradually from £6·76 in 1867 to £4·76

II.—Distribution of Home Produce Exported.

Note.—Since 1870, the Exports of Home Produce are given only in Sterling Value under the heading, "Clocks, Watches, and parts thereof."

COUNTRY.	1867.				1868.				1869.			
	Clocks.		Watches.		Clocks.		Watches.		Clocks.		Watches.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
		£		£		£		£		£		£
Argentine Confederation ...	...	...	193	2,518	...	...	213	1,436	...	...	96	1,720
Australia	4,248	4,985	...	...	5,168	5,588	...	...	7,864	7,202	193	1,052
Belgium	...	...	...	...	...	...	1,100	4,617	...	...	1,662	8,240
Brazil	...	...	196	2,489	...	...	95	1,026	922	1,511	168	2,088
British India—												
Bombay and Scinde	1,172	1,807	...	...	2,245	2,912	...	...	3,036	4,142	...	...
Madras	444	496	...	...	737	921	...	...	912	1,122	...	...
Bengal and Burmah	1,280	4,625	...	...	934	2,463	...	...	1,468	3,664	...	...
British North America	...	...	...	...	...	...	463	1,714	...	...	280	1,134
,, Possessions in South Africa	515	982	...	...	461	454	...	...	492	1,019	...	...
Central America	...	...	...	...	...	...	...	...	...	...	315	3,975
Channel Islands	...	...	2,057	6,095	198	825	2,639	5,470	620	935	2,311	5,580
China	...	...	...	...	...	...	...	...	211	560	...	...
Chili	...	...	...	...	...	...	...	...	...	...	90	1,263
Cuba	...	...	...	...	...	...	...	...	...	...	...	...
Egypt	131	558	3,711	28,832	...	...	3,680	29,119	542	957	8,212	46,869
France	169	979	...	...	458	631	...	...	279	724	...	...
Hong-Kong	602	893	...	...	517	504	...	...	...	...	...	...
Malta	...	...	...	...	...	...	...	...	...	...	...	...
New Granada	...	...	397	2,921	...	...	917	4,142	...	...	441	1,287
Russia	...	...	...	...	...	...	...	...	...	...	...	...
Spain and Canaries	...	...	...	...	...	...	...	...	64	897	...	...
Straits Settlements	...	...	...	...	...	...	...	...	...	...	...	...
Sweden and Norway	...	...	...	...	...	...	...	...	...	...	...	...
Turkey Proper	...	...	...	...	...	...	...	...	...	...	...	...
United States—Atlantic	...	...	818	7,265	91	450	787	6,132	...	...	648	3,830
,, Pacific	...	...	...	...	...	...	...	...	...	...	...	...
West Indies—British	...	...	...	...	...	...	...	...	...	...	...	...
,, Foreign	...	...	...	...	...	...	...	...	...	...	...	...
Other Countries	2,893	5,100	1,668	11,021	2,966	5,823	1,022	6,376	2,674	3,746	1,948	5,558
Total	11,454	20,425	9,040	61,141	13,805	20,571	10,925	60,032	19,084	26,479	16,364	82,596
Mean Price	£1·78		£6·76		£1·49		£5·49		£1·38		£5·05	

COUNTRY.	1870.				1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.
	Clocks.		Watches.											
	No.	Value.	No.	Value.										
		£		£	£	£	£	£	£	£	£	£	£	£
Argentine Confederation	...	...	143	2,013	2,632	2,563	...	...	...	...	...	...	...	...
Australia	3,703	4,714	...	...	4,923	15,145	43,150	41,231	33,129	38,328	38,397	32,741	33,178	28,744
Belgium	...	...	1,497	7,221	11,507	10,704	23,515	25,503	28,330	27,211	38,740	28,080	31,660	32.431
Brazil	4,215	3,265	612	3,955	6,554	4,496	6,208	...	4,298	...	...	2,945	3,410	2,687
British India—														
Bombay and Scinde ...	4,623	3,943	...	...	3,158	2,863	4,559	5,634	5,442	6,193	2,951	3,328	2,990	2,855
Madras	731	976	...	...	...	...	2,166	1,463	2,165	1,360	1,470	1,815	1,021	...
Bengal and Burmah ...	1,085	3,598	...	...	...	3,919	4,079	5,011	6,708	5,532	6,652	6,809	6,340	8,048
British North America ...	504	605	192	1,013	5,482	3,308	3,827	3,470	...	...	...	...	...	5,860
,, Possessions in South Africa ...	607	752	188	1,151	...	8,098	11,644	10,994	9,479	8,742	7,911	9,085	16,871	14,704
Central America	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Channel Islands	...	...	1,452	4,101	...	...	...	...	...	...	...	...	...	...
China	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Chili	384	519	372	1,897	2,027	...	...	...	...	...	...	...	...	...
Cuba	...	...	212	1,740	...	...	...	...	...	...	...	...	...	...
Egypt	198	803	8,383	37,741	24,630	28,271	9,477	...	1,898	1,372	1,629	662	1,261	...
France	...	...	...	...	2,402	4,714	6,489	6,067	6,374	9,010	9,845	10,629	8,780	8,325
Hong-Kong	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Malta	...	...	215	1,039	...	...	...	...	...	...	...	...	...	...
New Granada	...	...	1,166	12,221	15,546	11,530	9,370	...	878	2,334	634	681	620	...
Russia	...	...	...	...	3,599	...	...	...	...	...	...	...	...	...
Spain and Canaries	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Straits Settlements	625	510	...	...	...	...	...	...	...	...	...	...	2,020	3,146
Sweden and Norway	...	...	...	...	3,108	8,053	3,136	4,146	...	...	...	...	...	...
Turkey Proper	...	...	739	1,814	2.113	4,061	...	...	...	...	...	...	...	...
United States—Atlantic	...	...	1,443	7,849	59,936	14,606	23,319	12,596	16,636	30,079	21,275	23,152	26,440	29,979
,, Pacific ...	...	...	...	...	37	66	...	90	349	...	...	...	...	...
West Indies—British ...	...	...	204	908	...	...	...	...	...	...	...	...	...	...
,, Foreign ...	...	...	...	...	7,264	...	...	...	...	...	...	...	...	...
Other Countries	4,233	4,731	2,442	6,972	17,189	19,909	27,150	30,589	27,788	26,737	25,446	20,963	20,539	20,038
Total	20,908	24,416	19,280	91,635	172,107	142,306	178,089	146,794	143,494	156,898	154,950	140,890	155,130	156,817
Mean Price ...	£1·16		£4·76											

III.—Distribution of Foreign Clocks Exported.

Note.—The Distribution of Foreign Watches Exported is not given at all in the returns, neither is that of Clocks during the years 1867-70.

Year.	Australia.		British India.		Straits Settlements.		Sweden and Norway.		Other Countries.		Total.		Mean Price.
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	
		£		£		£		£		£		£	£
1867	...	...	...	...	...	...	...	...	...	...	10,372	5,843	0·56
1868	...	...	...	...	...	...	...	..	...	...	5,827	7,962	1·36
1869	...	...	...	...	...	...	...	...	...	...	7,650	7,013	0·92
1870	...	...	...	...	...	...	...	...	...	...	12,124	9,454	0·78
1871	4,007	3,220	4,775	3,144	917	757	...	...	6,816	5,343	16,515	12,464	0·76
1872	5,175	5,121	6,361	4,781	1,510	1,323	4,714	2,532	7,708	7,047	25,468	20,804	0·81
1873	6,399	6,493	1,453	1,614	1,322	1,123	3,204	1,848	7,447	8,005	19,825	19,083	0·96
1874	7,313	7,272	4,533	3,522	1,984	1,471	3,653	2,117	7,638	6,112	25,121	20,494	0·81
1875	8,166	6,992	2,892	2,434	1,425	1,214	7,061	3,959	8,366	6,377	27,910	20,976	0·75
1876	9,220	8,202	2,769	2,218	...	...	22,790	11,744	9,679	7,380	44,458	29,544	0·66
1877	7,608	8,032	4,240	2,533	...	...	25,913	7,519	13,866	9,027	51,627	27,111	0·52
1878	11,051	7,700	7,465	4,884	...	...	14,713	4,180	23,565	12,866	56,794	29,630	0·52
1879	9,558	7,183	8,359	4,395	...	...	11,256	3,358	40,060	23,404	69,233	38,340	0·55
1880	16,853	7,056	16,843	8,321	9,737	4,702	12,386	6,427	94,399	46,990	150,218	73,496	0·49

in 1870. The mean price of English clocks exported fell in about the same proportion. Our best customer is Australia; Belgium generally comes next, and the large amount of our exports to the United States will be a matter of surprise to many.

Table III.—This gives information similar to that contained in Table II, but in regard to foreign clocks exported from this country. The returns do not give such details in regard to foreign watches, except in one or two isolated cases, which I shall record in the notes to Table IV. These returns show that our exports of foreign clocks have been steadily increasing for many years past, and in 1880 there was an extraordinary expansion, the figures representing both number and value, being nearly double those of the preceding year.

One feature of this Table III. to which I would draw attention, is the large export of foreign clocks to Sweden and Norway from this country; it is certainly unexpected. In the exports to "Other Countries" in 1879 are included 1,049 foreign clocks (valued at £4,920) sent to France, and 14,079 (valued at £7,066) sent to China. Exports during 1880 to countries not provided for in the Table (which I have included under "Other Countries") are:—

	No.	Value.
China	31,878	£11,810
France	1,613	6,162
Hong Kong..	24,527	11,241
Japan	19,329	8,125

IV.—Summary of Exports.

Year.	Home Produce.	Foreign Clocks.		Foreign Watches.	Total.
		Number.	Value.		
	£		£	£	£
1867	98,697	10,372	5,843	3,291	107,831
1868	93,997	5,827	7,962	3,515	105,474
1869	121,258	7,650	7,013	3,114	131,385
1870	146,186	12,124	9,454	29,257	184,897
1871	172,107	16,515	12,464	59,900	244,471
1872	142,306	25,468	20,804	8,732	171,842
1873	178,089	19,825	19,083	6,479	203,651
1874	146,794	25,121	20,494	3,942	171,230
1875	143,494	27,910	20,976	7,479	171,949
1876	156,898	44,458	29,544	19,397	205,839
1877	154,950	51,627	27,111	24,043	206,104
1878	140,890	56,794	29,630	30,600	201,120
1879	155,130	69,233	38,340	30,345	223,815
1880	156,817	150,218	73,496	26,017	256,330

Table IV.—Table IV., giving an annual summary of the exports, is convenient for reference, and is the best index of the state of the English trade that the statistics afford. There is a decided tendency to rise in the column headed "Home Produce;" indeed the last figure, that for 1880, is actually £5,512 above the mean of the previous thirteen years. The exports of foreign produce may, from a commercial point of view, be regarded as forming part of the home trade; they also show a decided rise; we are therefore safe in concluding that the English trade is certainly not in such a depressed state as some would have us believe, and 1880 stands out as the one in which a far greater amount of foreign trade was done than in any previous year.

The returns add the following particulars, which I will give for the sake of completeness, although they are of no special moment:—

Foreign Watches Exported.

1871.	To the United States	£47,606
	,, Other countries	12,294
1876.	,, Belgium	17,169
	,, Other countries	2,228
1877.	,, Belgium	21,731
	,, Other countries	2,312
1878.	,, Belgium	26,612
	,, Other countries	3,988
1879.	,, Belgium	21,302
	,, Other countries	9,043
1880.	,, Belgium	20,274
	,, Other countries	5,743

Table V.—As, prior to 1870, numbers as well as value were always given in regard both to imports and exports, I have added this table, which consists mainly of "Mean Prices" calculated from these returns. The mean price of both clocks and watches of home manufacture exported fell regularly as already mentioned; and full details are given of the manner in which other prices varied, as well as all particulars of the numbers of the several articles imported and exported.

The figures in regard to chronometers exported cannot be taken as in any way an index of the amount of our foreign trade in that branch, for many vessels obtain their supply when in an English port, and this would naturally not be included as an "export."

The last column of the table gives the average mean prices during the four years under consideration, and, taken in conjunction with the preceding tables, they constitute the sole means at our disposal for ascertaining approximate numbers in recent years. Thus, taking £5·41 as the average price of an exported English watch, and remembering the fact, already mentioned in speaking of Table II., that about 60 per cent. of the total exports are watches, it appears from the second column of Table IV. that, for example, in 1880, we exported about £100,000 in English watches, and that their number was approximately $\frac{100,000}{5 \cdot 41}$ or 18,480. The mean price of an imported foreign watch being taken to be £1·60, it appears from the last column but two of Table I., that in the same year we imported for home consumption $\frac{401,646}{1 \cdot 6}$ or 251,030 foreign watches, to which we may probably add about 20,000 of American manufacture that are not included in the returns. Now, the last census showed that there were 23,766 men and 749 women engaged in the clock and watch trade in the United Kingdom, or a total of 24,515. Thus it appears that we actually did not export one watch per head of the watchmaking population, and imported about ten. It would perhaps have been fairer to compare the population with the returns for 1871, the year of the Census. The export of home watches was then about $\frac{115,000}{5 \cdot 41}$ or 21,250, and the net imports of foreign watches $\frac{409,514}{1 \cdot 6} = 255,970$, and the proportion therefore is even worse (as 1 is to 12).

Table VI.—This table gives the returns of watch cases hall-marked at the several Assay Offices; numbers that have hitherto been accepted as an index of the state of trade in this country. But a little consideration will suffice to show that they are subject to much uncertainty, and liable to be fallacious when used for such a purpose, for many cases are imported in order to receive the hall-mark, and subsequently enclose foreign-made works. Their number is very uncertain, but it will be seen from the information supplied by the Chester Assay Office authorities that since the year 1876, when cases appear to have been first brought to England for this purpose, they have averaged about 13,000 per annum at Chester, and of these not more than 7·5 per cent. have been gold. This latter fact seems to point to the conclusion that the gold cases marked would afford a fairer index of our trade than the total number, and, if it be accepted, the returns for the last five years certainly indicate a steady fall in the production. At the same time it is well to note that, judging from the Chester returns alone, the number of silver cases of home manufacture shows a very large increase, and a gradual decline observable in the number of foreign cases marked at that office justifies the conclusion that the diminution in the total numbers is not entirely borne by the English trade. Further uncertainty is occasioned by the fact that many English cases are fitted with foreign-made movements, and we have no means of ascertaining how their number varies from year to year.

And there is yet another source of uncertainty in these hall-marking returns as an index of the watch trade. The Birmingham Office records the cases by gross weight, and the numbers given are calculated on the assumption that each case weighs about $1\frac{1}{2}$ oz.; but this is obviously liable to considerable error, more especially if many foreign cases are included, as they never reach that weight.

There is one fact, then, which the statistics I have been able to collect bring into striking prominence; it is the utter impossibility of drawing any reliable conclusions as to the state of the English trade from these returns of the several Assay Offices. The year 1879, affords a remarkable instance of this fact. In comparing the number of cases marked at Goldsmiths'-hall during that year, with those of years immediately preceding it, the *Horological Journal*, in January, 1880, observed:—"Short of absolute extinction, the English watch manufacture certainly reached as low a point as possible during the year just passed." Now, in the light of these official returns, what are the facts? The net imports (Table I.) were £2,500 above the average of the previous nine years, and the exports of home produce (Table IV.) were £1,600 above the average for the same period.

The returns of the total export trade, that is inclusive of foreign clocks and watches, given in Table IV., afford still more conclusive evidence of the relative prosperity of 1879. They reached a value of £223,815, considerably in excess of the value in any previous year, except 1871, when the exports were abnormally expanded by £47,606 in Swiss watches sent to America. And the exports during that year are even exceeded by those of 1880, which shows a gross increase of £32,515 over 1879, mainly owing to the foreign clocks re-exported being largely in excess, although there is a distinct rise in home produce.

V.—Further Particulars in regard to the Years 1867—1870.

EXPORTS.	1867.	1868.	1869.	1870.	Average of the Four Years.
Home Produce.					
Clocks—Mean Price	£1·78	£1·49	£1·38	£1·16	£1·41
Watches—Mean Price	£6·76	£5·49	£5·05	£4·76	£5·41
Chronometers—Number	69	85	121	90	
Value	£1,894	£2,362	£3,098	£2,754	
Mean Price	£27·45	£27·79	£25·60	£30·6	£27·69
Clock and Watch Movements—Value	£15,237	£11,032	£9,085	£27,381	
Foreign Produce.					
Clocks—Mean Price	£0·56	£1·36	£0·92	£0·78	£0·84
Watches—Gold: Number	149	180	287	2,163	
Value	£1,357	£2,134	£2,076	£18,878	
Mean Price	£9·11	£11·85	£7·23	£8·73	£8·73
Silver, &c.: Number	872	1,068	1,106	7,889	
Value	£1,934	£1,381	£1,038	£10,379	
Mean Price	£2·22	£1·29	£0·94	£1·34	£1·35
Mean price of all Foreign Watches exported	£3·22	£2·89	£2·24	£2·91	£2·86
Total Number	1,021	1,248	1,393	10,052	
IMPORTS.					
Belgium.					
Gold Watches—Number	653	870	1,355	17,852	
Value	£3,342	£4,654	£7,200	£80,289	
Mean Price	£5·11	£5·34	£5·31	£4·49	£4·63
Silver and other Watches—Number	3,988	3,193	4,979	97,555	
Value	£4,906	£4,010	£6,962	£141,434	
Mean Price	£1·23	£1·25	£1·39	£1·45	£1·44
Total Number of Watches	4,641	4,063	6,334	115,407	
Mean Price	£1·77	£2·13	£2·23	£1·92	£1·94
France.					
Gold Watches—Number	23,480	24,145	29,314	22,494	
Value	£69,580	£73,987	£78,034	£52,202	
Mean Price	£2·90	£3·06	£2·66	£2·32	£2·75
Silver and other Watches—Number	90,807	90,894	93,671	71,798	
Value	£108,460	£109,690	£105,023	£76,116	
Mean Price	£1·19	£1·20	£1·12	£1·06	£1·15
Total Number of Watches	114,287	115,039	122,985	94,292	
Mean Price	£1·56	£1·68	£1·48	£1·36	£1·51
Other Countries.					
Gold Watches—Number	247	390	66	2,452	
Value	£1,747	£2,947	£1,002	£9,729	
Mean Price	£7·07	£7·55	£15·18	£3·97	£4·88
Silver and other Watches—Number	522	1,785	327	10,986	
Value	£1,148	£3,568	£986	£12,650	
Mean Price	£2·20	£1·99	£3·01	£1·15	£1·35
Total Number of Watches	769	2,175	393	13,438	
Mean Price	£3·76	£2·99	£5·06	£1·66	£2·01
Total—					
Gold—Number	24,380	25,405	30,735	42,798	
Value	£74,669	£81,588	£86,236	£142,220	
Mean Price	£3·06	£3·21	£2·80	£3·32	£3·12
Silver, &c.—Number	95,317	95,872	98,977	180,339	
Value	£114,514	£117,268	£112,968	£230,200	
Mean Price	£1·21	£1·22	£1·13	£1·27	£1·21
All kinds—Number	119,697	121,277	129,712	223,137	
Mean Price	£1·58	£1·64	£1·53	£1·67	£1·60

VI.—Watch-cases Hall-marked.

Year.	GOLD. Birmingham.	Chester. English.	Chester. Foreign.	London.	Total.	SILVER. Birmingham.	Chester. English.	Chester. Foreign.	London.	Total.	Grand Total.
1867	...	7,499	...	25,501	33,000	8,726	17,023	...	97,570	123,319	156,319
1868	...	11,446	...	24,952	36,398	7,834	17,345	...	85,995	111,174	147,572
1869	2	10,858	...	25,210	36,070	8,374	15,583	...	83,439	107,396	143,466
1870	42	12,050	...	24,881	36,973	8,342	14,763	...	86,260	109,365	146,338
1871	...	12,549	...	25,780	38,329	9,018	18,395	...	96,543	123,956	162,285
1872	...	12,919	...	28,441	41,360	13,608	28,993	...	103,271	145,872	187,232
1873	2	12,503	...	30,894	43,399	17,106	36,423	...	108,971	162,500	205,899
1874	3	11,987	...	31,234	43,224	22,448	34,564	...	109,814	166,826	210,050
1875	6	11,595	...	32,888	44,489	21,648	25,778	...	112,323	159,749	204,238
1876	42	10,728	395	34,844	46,010	24,930	24,618	10,224	119,394	179,166	225,176
1877	113	10,189	1,000	31,212	42,579	37,834	24,651	20,704	115,123	198,312	240,891
1878	323	9,429	571	30,161	40,484	32,520	43,345	12,655	101,017	189,537	230,021
1879	600	7,799	1,201	24,558	34,158	30,692	39,262	10,738	92,730	173,422	207,580
1880	634	7,191	1,309	21,498	30,632	40,030	39,653	8,347	87,327	175,357	205,989

But these returns prove another point which is less satisfactory. While they show that our export trade in 1879 and 1880 were above the average of preceding years, they also show that the rapidly increasing home demand is, at least to a very large extent, supplied by foreign makers, so that our credit abroad actually appears to be better than in this country.

The cause of the difference of £1·26 between the prices of imported and exported foreign watches is not clear; it is, however, probably in the main, due to the fact I have already mentioned, that many of the latter come to this country to be cased; in instituting a comparison, therefore, with those of home manufacture, it would be fairer to take the two export prices rather than the import and export.

It is unfortunate that more recent details in regard to the mean price are not accessible, but, accepting those already given for 1867-1870, is it fair to conclude that the average English watch exported is so much superior to the average foreign watch, as to justify so marked a difference in price as there is between £5·41 and £2·86? Few will, I think, be prepared to maintain that it is not open to question, and however hopeful statistics may be, the trade cannot be said to be in a satisfactory condition until either such a difference is justified, or the price is reduced.

In considering such a subject, there are many circumstances to be taken into account. High quality must always depend largely on the education of the workman, and the honesty with which he does his work; moderate price must be aimed at by systematising the manufacture, and will always be in a great measure influenced by the amount of production.

(*To be continued.*)

MISCELLANEOUS.

CITY AND GUILDS OF LONDON INSTITUTE.

The first stone of the Central Institution of the City and Guilds of London Institute for the Advancement of Technical Education, was laid on Monday, 18th inst., by his Royal Highness the Prince of Wales, who was accompanied by the Princess of Wales. The building will have a piece of land in the Exhibition-road, South Kensington, between the Indian Museum and the Albert Hall, granted to the institute at a nominal rent by the Commissioners of the Exhibition of 1851.

The Lord Chancellor said—May it please your Royal Highness, I have to express, on behalf of the council of the institute of which I have the honour to be chairman, our gratification at your presence here to-day to lay the foundation stone of the Central Institution of the City and Guilds of London Institute for the Advancement of Technical Education, and, at the same time, to offer our grateful thanks to her Royal Highness the Princess of Wales for the interest which she has been graciously pleased to manifest in our work by accompanying your Royal Highness on this occasion. The council and the governors of the institute have heard with unmixed satisfaction that your Royal Highness has graciously consented to become the President of this association, the objects of which are the improvement of the industrial and commercial pursuits of this country, by affording facilities to apprentices, foremen, managers of works, and manufacturers, to become practically acquainted with the principles of science and art in their application to industrial operations. The institute has grown up by the united efforts of a few of the ancient guilds of London, which, having combined for the purpose of assisting in the advancement of technical education, obtained later on the help of the Corporation of London and of other livery companies, 22 of which, including nine out of the 12 great guilds, are represented on the council of the institute, and jointly contributed nearly £21,000 annually to its funds. At first, the efforts of this association were confined to the encouragement of technical education in schools and colleges in London and elsewhere; but latterly the institute has been enabled to establish and organise schools of its own for technical instruction, and also to assist in the development of technical education in a large number of towns in the United Kingdom. This institution will not be established as a rival to any other existing seat of learning; least of all to the excellent schools situated in this neighbourhood, which for some years past have been the means of offering to hundreds of young men and women a knowledge of the principles of science and art. The aim of this institution will be to supplement the teaching of those schools, by giving instruction in the practical application of science and art to the trades and industries of the country, and by cultivating and endeavouring to stimulate inventive genius. As President of the Royal Commission for the Exhibition of 1851 this institution is already greatly indebted to your Royal Highness and the other members of the Commission, for their gift at a nominal rental of the valuable plot of ground on which this institution is to be erected. The institute is gratefully sensible of its obligations to her Majesty's Commissioners, without whose kindly assistance the erection of this college might possibly have been delayed. It gives me great pleasure to be enabled to add that it has seemed fit to her Majesty to recognise on this occasion the eminent services of Mr. Bramwell, the indefatigable chairman of the executive committee of the institution, by signifying her Majesty's gracious intention of conferring upon that gentleman the honour of knighthood. It is anticipated that the cost of this building, when fully equipped with the apparatus and appliances needful for technical instruction, will not fall far short of £75,000. Of this sum £31,000 has been already subscribed by the worshipful companies of Fishmongers, Goldsmiths, Clothworkers, and Cordwainers; the grant of the Drapers' Company having been appropriated to the Finsbury College; and it is expected that about £24,000 will be saved from the annual income of the institute during the building of this college. The Council therefore, after paying the amount which is due, will have at their disposal only an estimated sum of about £55,000, and they look to the liberality of the Livery Companies, both of those who have and of those who have not as yet subscribed to the funds of the institute, to make good the balance of £20,000, so that the building of this college may be completed at once and as a whole, in strict accordance with the plans. It is confidently hoped that the presence of your Royal Highness and of her Royal Highness the Princess of Wales here to-day, sanctioning and approving the objects for which this institute has been founded, and for the promotion and further development of which this central institution is to be erected, and also the proof of her Majesty's gracious approval which I have been enabled to announce, will stimulate the City and Guilds of London liberally to bestow their funds upon the work which they have so wisely and honourably inaugurated, so that this important edifice, the first stone of which is to be now so auspiciously laid, may be worthily established and adequately endowed.

His Royal Highness the Prince of Wales then said,—My Lord Chancellor, my Lords, Ladies, and Gentlemen,—I thank you for your address, and beg leave to assure you that it gives me much satisfaction to attend here to-day, to lay the foundation stone of an institution which gives such forcible expression to one of the most important needs in the education of persons who are destined to take part in the productive history of this country. Hitherto English teaching has chiefly relied on training the intellectual faculties, so as to adapt men to apply their intelligence to any occupation of life to which they may be called; and this general discipline of the mind has, on the whole, been found sufficient, until recent times; but during the last 30 years, the competition of other nations, even in manufactures which once were exclusively carried on in this kingdom has been very severe. The great progress that has been made in the means of locomotion, as well as in the application of steam for the purposes of life, has distributed the raw materials of industry all over the world, and has economised time and labour in their conversion to objects of utility. Other nations which did not possess in such abundance as Great Britain coal, the source of power, and iron, the essence of strength, compensated for the want of raw materials by the technical education of their industrial classes, and this country has, therefore, seen manufactures springing up everywhere guided by the trained intelligence thus created. Both in Europe and in America, technical colleges for teaching, not the practice, but the principles of science and art involved in particular industries, had been organised in all the leading centres of industry. England is now thoroughly aware of the necessity for supplementing her educational institutions by colleges of a like nature. Let me remind you that the realisation of this idea was one of the most cherished objects which my lamented father had in view. After the Exhibition of 1851, he recognised the need of technical education in the future, and he foresaw how difficult it would be in London to find space for such museums and colleges as those which now surround the spot on which we stand. It is, therefore, to me a peculiar pleasure that the Commissioners of the Exhibition, of which I am the President, have been able to contribute to your present important undertaking, by giving to you the ground upon which the present college is to be erected, with a sufficient reserve of land to ensure its future development. Allow me, in conclusion, to express the great satisfaction which I experience in seeing the ancient guilds of the City of London so warmly co-operating in the advancement of technical instruction. I am aware that several of them have for some time past in various ways separately encouraged the study of science and art in the metropolis, as well as in the provinces; and it is a noble effort on their part when they join together to establish a united institute with the view of making still greater and more systematic endeavours for the promotion of this branch of special education. By consenting at your request to become the president of this institute I hope it may be in my power to benefit the good work, and that our joint exertions, aided, I trust, by the continued liberality of the City and Guilds of London, may prove to be an example to the rest of the country to train the intelligence of industrial communities, so that, with the increasing competition of the world, England may retain her proud pre-eminence as a manufacturing nation.

Mr. F. J. Bramwell then presented to his Royal Highness a medal, which had been struck at the Royal Mint commemorating the laying of the stone, bearing on the obverse the shields of all the contributing Companies, and on the other side a record of the event to take place that day.

Sir Sydney H. Waterlow handed to his Royal Highness, who placed it in a cavity in the stone, a glass and metal case containing the smaller weights of the country, coins, and a copy of *The Times*, *Nature*, and the *City Press*; also a medal and a document recording the laying of the stone.

Mr. Norman Watney having presented to his Royal Highness a handsome silver and ivory trowel, the column of polished granite was then lowered into its proper position.

The Prince of Wales then said,—In the name of the Father, the Son, and the Holy Ghost, I declare this stone to be duly laid.

THE MINT.

The eleventh annual report of the Deputy-Master of the Mint has lately been issued, and the following is an abstract of its contents:—

The demand for bronze coin having been far below the average, it has not been necessary to provide for the execution of any part of the coinage by contract during the year, but the Department has been fully occupied in meeting the demand for gold and silver coin, and in supplying three unimportant coinages to colonies. Three other colonial coinages, of larger amounts, which pressure of work did not permit the Mint to undertake, were executed by contract under the supervision of the Department. The requirements of the Bank of England were met by a coinage of rather more than £4,000,000 of gold, or about £1,000,000 less than the average, but the coinage of silver, which has exceeded £744,000, has been larger than that of any year since 1874. The coinage of bronze, on the other hand, has barely exceeded £19,000, as against an average of £42,600 in the preceding five years.

The coins struck during the year 1880 were of twenty-three different denominations. The total number of pieces struck at the Mint was 26,870,533, as against 30,050,311 in 1879, and their value, real or nominal, £4,926,255 15s. 8d. The total number of British coins struck during the year was 25,812,033, and their value was as follows:—Gold, £4,154,604 10s.; silver, £744,829 8s. 11d.; bronze, £19,471 16s. 9d.

Gold Coinage.

The coinage of gold commenced in December, 1879, and was concluded in July, 1880. The amount coined in 1879 was insignificant, but during the first six months of 1880, a sum of rather more than £4,150,000 was delivered to the Bank of England in sovereigns and half-sovereigns, and the total value of the coinage was brought up to £4,185,120. This is the largest gold coinage executed since 1876, when the amount issued in the year was £4,700,000. During the intervening period of three years, owing to the general depression of trade, the annual average demand for gold coin from the Mint has been but little more than £1,000,000, the importations of sovereigns issued by the Sydney and Melbourne Mints having each year been sufficient to make up the quantity of new coin required by the Bank of England. During the year 1880 the amount of Australian gold coin imported was £2,377,000, as against the following amounts in the preceding five years:—

1875	£2,726,000
1876	2,075,000
1877	3,748,000
1878	2,773,000
1879	1,617,000

Silver Coinage.

The silver coinage of the year, as already stated, was considerably above the average. The amount of coin struck was £744,829, as against £567,125 in 1879, and £614,426 in 1878, and the amount issued £709,093. The issues consisted of £190,700 sent to the Bank of England, £122,000 to the Bank of Ireland, £73,500 to Scotch banks, and £308,940 to colonies; £13,250 shipped in aid of Treasury chests abroad, and £500 in threepences supplied direct to banks and private persons. As in

ormer years, applicants for small sums in threepences were referred to London banks which had intimated that they held a stock in excess of their own requirements, and the amount sold to individuals, therefore, was inconsiderable; but the total amount issued, nevertheless, reached £23,050. This amount, though less than the issues of 1879 and 1878, which were £37,220 and £30,425 respectively, shows that the demand for threepences is still very large. It may be mentioned in this place that fourpences, none of which have been coined since 1856, continue to be withdrawn in considerable quantities, and will shortly no doubt almost entirely disappear from circulation. The nominal value of the fourpences withdrawn during the past year was about £4,000, and in 1879 was £3,600, so that the number of these pieces in circulation has been reduced in two years by not less than 456,000.

The half-crowns issued during the year have been of the nominal value of £164,920, and the total amount of these coins issued since 1874, when their coinage was resumed, has been £992,070.

There has been a decided increase in the demand for silver coin in England and Wales during the past year. In the latter part of 1878, and during the greater part of 1879, owing to the general contraction of trade and the depression of agriculture, large quantities of coin were received back by the Bank from the public; but, in 1880, the issues again largely exceeded the amounts received, and the silver currency, therefore, may be considered to have resumed its normal condition. The amount of worn silver coin withdrawn from circulation, £250,000, continues to be large, and shows that the renewal of the coinage progresses satisfactorily.

In Scotland and Ireland also, the demand for silver coin has been considerable.

Notwithstanding the large issues of 1879, which amounted to £298,470, the amount of new coin shipped to the colonies has during the past year shown no signs of diminution. The demand for silver coin throughout the colonies in which the Imperial coinage is current has been greatly stimulated by the arrangements made at the beginning of 1879, under which the Mint was authorised by their Lordships to pay all expenses connected with the carriage of new silver and bronze coin to, and of worn silver coin from, British dependencies.

In connection with the withdrawal of worn silver coin from circulation, the "Loss by Exchange" for the year 1880 was £58,696, as against £54,702 in 1879, although the amount of coin sent in for re-coinage in 1880 was only £485,015, as against £495,055 in the previous year.

The average market price at which standard silver has been purchased for coinage during the year 1880 has been 52½d. per ounce, so that, as the rate at which silver coin is issued by the Mint is 66d. per ounce, the seignorage accruing to the State has been at the rate of 13⅝d. per ounce, or 26⅝ per cent.

BRONZE COINAGE.

The bronze coinage of the year, as already mentioned, has been comparatively small, having only amounted to £19,400, and the issues, though exceeding this sum by £9,000, have still fallen short of those 1879 by no less than £10,000. It would appear, therefore, that the very large issues made since the first introduction of the bronze coinage in 1860, which amounted up to the end of last year to £1,475,608, have at length begun to affect the demand.

Of the amount issued in 1880, £19,640 consisted of pence, £6,058 of half-pence, and £2,772 of farthings, as against issues in 1879 of £28,050 in pence, £7,735 in halfpence, and £3,185 in farthings. The demand for each denomination of coin, therefore, has sensibly diminished.

The bronze metal purchased for coinage during the year amounted, as in 1879, to 100 tons, in bars ready for coinage.

The result of the general account of the expenses and receipts of the past year, as in the two previous years, has been a loss, but it is satisfactory to note that, whereas the excess of expenses over receipts was, in 1878, £51,543, and in 1879, £27,955, it was in 1880 reduced to £7,658. It might have been hoped, indeed, that as the purchases of silver bullion for coinage, which are generally the principal source of profit, were double as large in 1880 as in 1879, the receipts might once more have exceeded the expenditure; but the loss on the withdrawal from circulation of worn silver coin at its nominal value was again very large, and more than counter-balanced the profit on the conversion of the bullion into new coin, while the profit on the bronze coinage was slightly less than in 1879, and the "waste" on a gold coinage of £4,000,000, which came in course of payment during the year, formed a further item of loss. The transactions of the Mint, however, during the nine years which have elapsed since a "Profit and Loss Account" was first compiled in its present form, still show an annual profit of £17,920; and it may be expected that, as trade revives, the causes which now unfavourably affect those transactions will cease to exist.

COUNTERFEIT COINING.

The only counterfeit of special interest brought under the notice of the Mint during the past year, was a spurious sovereign of platinum found in circulation at Sydney, and forwarded by the Deputy-Master of the Sydney Mint, with a report of Dr. Leibius, assayer of that branch. Platinum counterfeits are well known, but the specimen in question bore traces of a previous impression, and it appeared probable at first sight that a genuine Russian platinum coin had been re-struck and gilt. After careful examination, however, it was found that on the obverse of the counterfeit the central escutcheon on the reverse of a Spanish Isabel, or 10-escudo piece, was clearly traceable, the figure "10" being also visible. It became evident, therefore, that the spurious sovereign had originally been a counterfeit of the Spanish gold coin.

OBITUARY.

Lord Hatherley, F.R.S.,—Lord Hatherley, whose death, at the age of 80, took place on the 10th inst. at his house in Great George-street, Westminster, was a member of the Society from 1859, in which year also he (then Vice-Chancellor Sir William Page Wood) was elected a Vice-President of the Society for the first time. In 1860 he took the chair, when a paper on "Science in our Courts of Law," was read by Dr. Angus Smith, and from that time till 1869, when he finally retired from the Council, he took an active part in the work of the Council and the committees of the Society. In recent years he was several times asked again to serve on the Council, but he declined, on the ground that his increasing years, while they brought no leisure, brought a diminished capacity for work, and he was always reluctant to allow his name to appear when he was unable to take a share of the work. But, though he had thus retired from active service to the Society, he was always ready to assist with his counsel and advice when it was required, and on various occasions the Society's interests thus profited by his aid. The full accounts of Lord Hatherley's personal history which have appeared in the daily and weekly newspapers, render it unnecessary to give any details of it in this *Journal*; nor would it be becoming here to do more than allude to the reverence and affection in which he was held by all who knew him. It may be interesting to say that he at all times took a keen interest alike in literary and in scientific progress. He was himself an author, his principal work being "The Continuity of Scripture," published in 1867. As far back as 1834 he was elected a Fellow of the Royal Society, and he has several times served on its Council.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, is now open daily. A non-transferable season ticket will be sent to any member of the Society on application to the Secretary. A ticket, to admit two persons, is sent with the present *Journal.*

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

WATCHMAKING,

By Edward Rigg, M.A.

LECTURE II.—(*Continued.*)

In this lecture I shall endeavour to explain very briefly the systems of manufacture in this and other countries, but would first say a few words on the design of the watch. This is a question which only practical watchmakers can discuss fully, but there certainly are faults in many English watches that even a non-technical observer cannot fail to have noticed. They are most marked in what is termed a full-plate watch, a watch, that is, in which the several moving parts are held in position by two circular plates, the balance occupying a position external to the rest of the train. This particular form has come to be known throughout the world as the "English watch," and it has existed with only one essential change, namely, in the form of the escapement, for the last 200 years, or even more. It is, at first sight, a matter of surprise, when we consider the changes that have been effected in all the sciences and the mechanical arts, that this piece of mechanism, important as it is to all classes of society, should have so long remained stationary, or nearly so. This fact has already been referred to in the first lecture, and reasons have been there given why we should not expect to find much radical change in its design. There does not so much appear to be occasion for the invention of new escapements, &c., as for the perfecting and simplifying of the watch as it already exists; and, above all, there is the need of replacing vague rules of thumb by definite principles of construction, and of taking advantage to the utmost limit, in practice, of the aid which theory has to offer.

Where is the necessity for making the English watch so much thicker than others? Why are we obliged to have a watch that involves opening the face to set to time? And why does a common Swiss or French watch often present a far more attractive external appearance than many of those of English make at twice the price? The faults in the design of the mechanism itself are quite as numerous, but I will not now stay to enumerate them, and to those who care to inquire into them would commend a suggestive article by Mr. Glasgow,* published only last year in the *Horological Journal.*

The criticisms that have to be met apply in the main to full-plate watches. This form has been gradually abandoned, in the case of high-class work, in favour of the half and three-quarter-plate, in which a portion of the top-plate is cut away, so that the balance may be in the same plane with or even below it, thus diminishing the thickness by about an eighth of an inch. The change was somewhat distasteful to the public at first, and there seems still to be an extraordinary amount of indirect opposition to it on the part of many workmen connected with the trade. Thus an escapement to a three-quarter-plate watch generally costs twice as much as for a full-plate watch, and a similar distinction is made in several other stages. But there seems no sufficient reason for so great a difference. It is, doubtless, in part owing to the fact that, as a rule, the three-quarter-plate watch is of a better quality, and work on it is, therefore, naturally more highly paid; but there appears to be no reason, unless public prejudice be considered one, why all qualities, even the lowest, should not be of similar design. Indeed, in Switzerland, the very cheapest watch manufactured is on the three-quarter-plate model.

The manufacture of a watch involves a very great number of distinct operations, each of which requires considerable knowledge and skill on the part of the workman.

During the sixteenth and seventeenth centuries, when pocket timekeepers were first introduced, the watchmaker, as a rule, himself made all the parts of both watch and case, employing only a few simple tools. But since that period the work has become gradually more and more subdivided, and each workman, by constantly confining himself to the making of one special object, is enabled, as in all handicraft, to make it both more rapidly and more accurately. At the same time, the simple tools of the early makers have been more or less elaborated, so as to abridge and facilitate the work—at times, indeed, to such an extent that the skilled workman himself is rendered unnecessary.

These latter machines are of comparatively recent introduction, and the collection of tools which I hope to exhibit on Monday next, show how much of the work of an ordinary watchmaker depends on his manual skill. But in recent years machine-tools have come more and more into use, and these have naturally tended towards the in-

* *Horological Journal* (1880), xxii., p. 92.

troduction of a factory system, in place of what was essentially a home manufacture.

Thus three systems are now possible for the production of watches on a large scale :—

(1.) Each workman, becoming an adept at one or more special trades, remaining independent, and working for a number of employers.

(2.) Workmen in all the trades being collected together in one large factory, which is thus in a condition to produce finished watches from the rough metal.

(3.) A combination of these two systems.

I propose to consider these separately, and will endeavour to point out some of their relative merits, as bearing on the English watch-making industry. The first is that mainly practised in England, Switzerland, and France. A frame, containing the barrel, fusee (if any), centre, third and fourth wheels, all with their teeth cut and pinions attached, and certain other portions in the rough, constituting a *movement*, is manufactured, say at Prescot, in Lancashire, and delivered to the Clerkenwell or Coventry manufacturer. After numbering it, he sends it, or the requisite portion, in succession, to the dial-maker, case-maker, escapement-maker, finisher, gilder, fusee-cutter, jeweller, &c., and, finally, to the examiner, who adjusts the balance-spring, and regulates the watch, returning it to the manufacturer. In all, at least 40 artificers aid in the production of a lever watch, but of these the most responsible is the finisher, whose duty it is to turn the pivots, preparing everything for the gilder, determining the positions of all the wheels, so that the train runs freely, drilling all pivot-holes, except those of the escapement, &c., but he does not, as his name would suggest, finish the watch. And the examiner is called upon to find out any faults in his predecessor's work, see that they are corrected, fix the balance-spring in position, and approximately regulate the watch.

It would be both tedious and unprofitable to attempt to pass in review the various stages through which a watch passes; but as the kindness of several manufacturers, both English and foreign, has supplied me with a number of movements, &c., mainly with a view to show the extent to which machinery is employed in their production on different systems, I think we may with advantage devote some time to their consideration and comparison. But we shall be more in a position to do so after the three systems of manufacture mentioned above have been passed in review.

Now, the high-class English watch furnishes a sufficient proof that splendid work can be produced under the first-named system, and it may be doubted whether, for such work, any better could be devised; for many of the operations seem to be exceedingly trivial, and it is improbable that any single manufacturer should have so large a trade as to enable him to retain the services of so many specially skilled operatives. At the same time, it should be observed that this cannot be regarded as an economical system. Babbage, in his "Economy of Manufactures," lays it down that the division of labour cannot be successfully practised unless there exist a great demand for its produce, and, considering as we are at present doing only the high-class watch, there can hardly be said to be such a demand. But the system is strongly recommended by the fact that it enables a number of manufacturers to avail themselves of the most highly trained workmen, when these are remarkably few in number, and would not otherwise obtain sufficient employment.

While other points must take precedence of economy in the case of high-class work, it is of primary importance with regard to cheaper watches. Foreign watches of good quality are now sold in this country at such low rates, that an English-made watch, if of medium quality, must be sold at a moderate price also, or it will most assuredly, in time, be driven out of the home market, as it has already been to a great extent from abroad. The minutest economies must, then, be practised at every stage of its manufacture, and all parts that are not essential to fair time-keeping must be avoided.

I feel considerable diffidence in saying anything on this question, as it is so essentially one for practical watchmakers, but I will briefly refer to one or two points for which the public are in a great measure responsible. If the buyers of watches—who, unfortunately, too often know nothing whatever of their internal arrangements—would content themselves with the selection of a suitable case, leaving it to the watchmaker to decide on the nature of the movement, a great step would be gained. But as long as there is a demand for cheap watches provided with fusee, compensation balance, full-plate, and the like, such watches will be made. The general introduction of keyless work has done much to prejudice the ordinary English trade, for its very manifest advantages have gone far to override the popular notion in favour of winding to the left, a feature by which the least initiated could distinguish our own from foreign movements. Indeed, so deep-rooted is this distinction in some districts, that the introduction of English going-barrel watches has been much impeded, and certain manufacturers have been induced to meet it by providing a separate axis for the winding square, which carries a steel wheel engaging with a similar wheel on the barrel arbor; the winding is thus to the left, and the absence of a fusee is not noticed.

This is only one example of the way in which prejudice interferes with the advance of the art. But it is perhaps the most important, as it involves the question whether the fusee shall or shall not be retained by English watchmakers. If the prejudice were done away with, the fusee could be regarded from the single point of view of its merits and defects, and it need not, as is at present the case, be retained partly as a question of policy. In the last lecture I endeavoured to explain what are the real advantages of the system, and why it should form a part in the high-class compensated and adjusted watch. If properly made, with a chain of sufficient thickness, it need not be a source of weakness, but the frequent breaking of chains, and the comparative difficulty of its repair by ordinary workmen, has done much to bring it into disrepute for cheaper watches. And, after all, is its retention to be desired in them? We have seen that its principal virtue consists in facilitating the adjustment for isochronism and positions. But it cannot be said that such watches as are here referred to are

adjusted for position and isochronism, and experience proves that they may be made to keep very uniform time from day to day, if wound up regularly, without any such adjustment, as well with a good going-barrel as with a fusee and chain; of this we have abundant evidence in the good rates of very many cheap French, Swiss, and American, as well as in English going-barrel watches. The latter type of construction, moreover, lends itself much more to the application of machinery in the manufacture, involves less risk of breakage and damage by careless workmen, and can be fitted with keyless work at far less expense. There appears then to be no real reason for the retention of the fusee in the class of watch we are considering, and I believe that, if it were not for the prejudice just referred to, manufacturers would be more ready and willing to abandon it.

The second system of manufacture referred to above, the system, namely, of collecting workmen of all the allied trades in one large factory, which is thus in a position to produce finished watches from the rough metal, has reached its most complete development in America. There are many factories on the Continent and in this country, but those in America are on by far the largest scale; indeed, they are, I believe, the only makers that claim to manufacture *every* part of a watch on the premises. And it will at once be evident that only very large producers could afford to do so, as many operations, though involving special skill, can be done with great rapidity, and thus workmen engaged on them would be kept idle, unless a proportionately increased number were engaged on the slower operations.

The Waltham Watch Factory gives employment to about 800 operatives, half of each sex, and produces about 100 finished watches a day, so that it does not experience the difficulty above referred to. There are 21 distinct departments, and every branch of the art, including, for example, hand, mainspring, and jewel-making is stated to be executed on the premises. Machinery is used to a very great extent, thus securing a high degree of uniformity in the work, besides greatly increasing the speed of production. And this brings me to the main characteristic of modern watchmaking; the employment of machine-tools and steam-power.

I would at once say a few words as to the meaning of the expression "machine-made watch," as I believe it is not fully understood, even by all watchmakers. Of course, in a sense, every watch would answer to such a description, as tools and machines of various kinds are employed in its construction. But the machines referred to are generally of a more elaborate character, and driven by power. They are, as a rule, of somewhat heavy construction, and their chief distinguishing feature is that, while every effort is made to facilitate their management, the power of repeating indefinitely a given operation with the utmost attainable accuracy, and without skilled supervision, is regarded as of primary importance. But this feature, the uniformity, can be very easily made too prominent. It is quite possible to produce the plates, bars, cocks, barrels, and even the wheels and pinions, so that they are, for all practical purposes, interchangeable, but when we come to the pivots, jewel-holes, and the various parts of the escapement, they are not so, in the same sense, and it seems too much to expect that machinery will ever make them so. I do not deny that it might be possible to replace any parts of one watch by the corresponding parts of another similar watch, but the chance of its keeping equally good time without further adjustment is small. Two pivots turned of the same thickness may require different degrees of polishing, and, therefore, their final diameters will differ. The accurate performance of an escapement depends on such a variety of conditions, that, although it may doubtless act when placed in a watch to which it does not belong, it cannot be expected to secure an equal rate without special adjustment.

I am aware that there is a considerable amount of opposition on the part of many watchmakers accustomed to the older system to the employment of machine-tools, but I venture to think that part of this is owing to a want of knowledge as to what may be legitimately expected of them, and part is probably due to the extravagant language too often employed in reference to this question. If our young watchmakers were brought up to be less exclusively watchmakers; if before making, say, an escapement, they could be induced to devote some of their time to a study of the tools they do use and might use, as well as to the actual making of such tools, there would, I feel convinced, be a natural tendency towards the principle of machine-tools. An ordinary pair of clockmaker's turns would, in the hands of an intelligent workman, lend itself to the construction of many devices for facilitating his daily work, and would often enable him to leave much of the work that now requires his personal supervision to a boy. Naturally, very little is known by watchmakers of the tools used in factories, but the kindness of many manufacturers, in London, Coventry, Prescot, and Birmingham, has enabled me to examine the machinery now in use, and I can most emphatically say that much of it will compare favourably with the watch itself in regard to accuracy of adjustment and beauty of finish. Tool-making is obviously of the first importance in a modern watch factory; and in Messrs. Rotheram's works at Coventry, I was much struck with a series of shops devoted specially to this branch, which appear to be provided with every available appliance for securing the most perfect workmanship in the machines they employ for watchmaking.

The history of the application of machinery to the watch manufacture has yet to be written. It appears that credit for its first suggestion cannot fairly be claimed by any one single inventor. Early in the present century, a number of manufacturers introduced it for special operations; and in 1839, Leschot established a machine-work movement factory in Geneva, which now belongs to the firm of Vacheron and Constantin. But P. F. Ingold, also a Swiss, appears to have first elaborated a series of both case and movement machines, their main feature being the production of any number of identical parts of a watch.

If we may credit the description given by Jurgensen of a machine designed by Ingold for making plates, they must have been extraordinarily complex. It was capable, he says, of producing a finished plate, polished, all the holes tapped for screws, steady-pin holes, including those for the escapement, with all the holes for the jewel

settings ready, sinks cut in the plate and polished both at the sides and bottom. His collection also included machines for making barrels, various parts of the escapement, together with balances, wheels, screws, and he had complete working drawings for watch-case machinery.

Ingold endeavoured unsuccessfully to establish a watch factory both here and on the Continent, and seems to have gone to the United States, about 1845, with the same object in view, but returned to Europe without having accomplished it.

In the report of the United States Commission on the Philadelphia Exhibition of 1876, group xxv., p. 90, it is stated that "In 1848, Mr. Dennison suggested to Mr. Howard the project of attempting the manufacture of watches by machinery, and two years afterwards, in company with Samuel Curtis, also of Boston, they established at Roxbury, Massachusetts, a factory of this kind. . . . . ." The reporter mentions these facts as evidence that his countrymen "first conceived the project to manufacture watches by machinery" (p. 89). But the machinery can only have been applied to a few branches of the art, for it is inconceivable that two years after the project was "suggested," they could otherwise have "commenced the manufacture of watches." Anyone who has seen the extraordinary variety of machines that go to produce a "machine-made watch," must admit that, even in the present day of rapid production, and with all the designs ready to hand, two years would be a very brief interval in which to establish such a factory. And at the above date, 1848, several factories were already employing machines in Switzerland, more especially at Geneva. The credit, therefore, of having first applied machine-tools to the manufacture of watches must be given to the Swiss.

In saying thus much in regard to the earlier applications of machinery, I would, of course, not be understood to deny that very much has been done in America to bring the system to a high degree of perfection. It was there that a sufficient amount of capital was first embarked in the undertaking to render a trial to the fullest extent possible. The well-known inventiveness of the American people has largely extended the use of machines, and they have done much to prove their applicability to watchmaking.

It is not, however, my present purpose to enter even briefly on the history of this question. I wish rather to show how far tools are used at the present day in the production of both English and foreign watches. A mere verbal explanation, besides being dry and uninteresting, would fail to convince, but I am fortunate in possessing a number of specimens of machine work for exhibition here this evening. And I would take this opportunity of expressing my sincere thanks to various firms who have so readily responded to my request by sending samples of their work, which in many cases must have been got together with no little trouble. The firms to which I am thus indebted are given alphabetically in the following list, together with the nature of the objects lent:—

Mr. Ehrhardt, Birmingham — Frames, with pivot-holes drilled.

The English Watch Co., Birmingham—Keyless watches, and their several parts in all stages of manufacture mounted on cards.

Messrs. Guye, London—Keyless watches, with machine-made escapements, steel work, pinions, pivots, &c.

Mr. Hewitt, Prescot, Lancashire—Movements, full, ½-plate and ¾-plate, keyless, with trains and steel work.

Messrs. Japy Frère, Beaucourt—Rough movement (*ebache*), with train.

Mr. Mercer, Clerkenwell—Stages of manufacture, by hand, of marine chronometer detent.

Messrs. Patek, Philippe & Cie., Geneva—Keyless movements, separate keyless mechanism and steel work.

Messrs. Rotheram, Coventry—Machine-made pinions, pivots, wheels, and wheel-blanks.

Mr. Taylor, Prescot—Chronometer wheels and pinions.

Mr. Tripplin, London — Details of finished Besançon watch.

The Waltham Watch Company, Mass.—Details of finished Waltham watch, with additional pieces to show pivoting, &c.

Mr. Wycherley, Prescot—Machine-made ¾-plate fusee movement; also detached pieces to show stages of manufacture from rough metal.

I propose to exhibit a selection from these specimens in the lantern, but would at once mention that the series lent me by the English Watch Company is very complete. It comprises a very great variety of pieces mounted on 13 cards, which may be regarded as typical of the many operations in watchmaking to which machinery is applied at the present day. I am not aware that so complete a series has been previously exhibited in this country, and cannot but feel that the collection is worthy of very careful study. If machinery can be arranged to produce some of the elaborate pieces shown on these cards, it can make almost anything; and, whatever we may say about interchangeability, there is no doubt that the parts will require a far less amount of fitting than they do on the hand system. It would be impossible for me to even enumerate the pieces that are here exhibited, and I will only draw your attention to one very marked feature, the immense amount of labour that is saved by the use of the punching machine. There are very few pieces in either the watch or case that do not in the first instance pass through this machine, and the amount of filing avoided must be immense.

It is difficult to form an exact estimate of the average number of machines employed in the manufacture of a watch. They will, in great measure, depend on the amount of production, since, of course, as this increases the tools will be more specialised. Mr. Gooding, of Messrs. Rotheram's, at Coventry, tells me that the number required for the movement, exclusive, that is, of the case, dial, hands, spring, and balance, may be taken at about 100, which is made up as follows:—

	Machines.
Plate making	13
Wheel and pinion	35
Steel work	12
Escapement	22
Jewelling	11
Screws	6
Total	99

And he estimates the time occupied in making a

watch by machinery at 30 hours, about half that required on the hand system.

There remains the third system of manufacture to consider, which is merely a combination of the two above referred to. It is the most generally adopted of all, but evidently will include very variously organised establishments distinguished primarily by the extent to which machine-tools are employed in the manufacture. The English system of the present day, as compared with that of ten or fifteen years ago, before movement making was accomplished by means of machines, would then come into this class. But what I rather intend it to include is the watch factory as we understand it in this country, one that builds up the complete timekeeper, but does not necessarily undertake such special work as cases, dials, balance-springs, mainsprings, balances, &c., or even escapements. Several of the English firms to whom I am indebted for assistance this evening would thus be included, and others exist. It cannot be doubted that such an establishment can turn out work of very uniform quality at moderate cost, and it possesses this advantage, that it may be of any required magnitude; the larger factory only differing from the smaller in that it comprises additional branches of the trade, generally involving skilled labour, which, if undertaken, might tend to increase the cost of production. Thus, take the case of jewel-setting. In one factory that I visited, two jewellers were able to do all the work. It is evident, therefore, that when less than half the number of watches is made in the same time, there would not be constant employment for even one jeweller, and it might be more economical to have the work done elsewhere. At the same time it may be presumed that the number of branches in which this holds good will gradually diminish till a limit is reached, as the employment of machines extends, for it will only involve machines standing idle for a definite period; or the practice, now very general, of adapting a single machine to several purposes would be applicable.

But I have said enough with regard to the system manufacture, and will proceed to consider the specimens on the table. At the outset one feature strikes us; all the types of watch, with the exception of some of the Prescot movements, have going-barrels, and these movements that form the exception are intended for completion on the hand system already explained. It is evident that the going barrel lends itself to machine work far more readily than the fusee, and one cannot but feel that an important reason for the opposition to the latter is to be found in this fact. Enough has, however, already been said on this subject, and I would only add that, admitting the applicability of machinery to the manufacture of watches, this is entitled to rank as a sound argument against the use of the fusee in ordinary watches.

[A large number of specimens illustrating the various stages of manufacture of watches, both on the machine and hand system, were here exhibited on the screen. They included many stages in the manufacture of the movement as practised in Prescot, rough movements from Birmingham, Beaucourt, Geneva, and London, as well as finished movement and parts of watches lent by the various firms to whom reference has already been made (p. 704). The images were obtained by direct reflection of the beam from an electric lamp, thrown on the surface of the object. The light being incident at very small angle, an image was obtained, very slightly distorted and in natural colours.]

The examination of these specimens, even in the very inefficient mode I have been compelled to adopt, must suffice to convince an unprejudiced observer that, at any rate for watches of ordinary quality, machinery can be extensively employed with marked advantage. It secures a greater degree of uniformity in the work, a more rapid production, and may reasonably be expected to reduce the cost of the watch. How far its use is desirable in the highest branches of the art is a question for practical horologists to discuss. In the best English watches uniformity is not of the same importance, and minute economies need not be so carefully practised. Indeed, the present system is well adapted to their production, as is sufficiently proved by the fact that foreign makers have not succeeded in underselling us in this particular grade. Each instrument receives an amount of individual attention that would almost involve a direct contradiction of the main principle on which the application of machinery is advocated—a principle which is often expressed by that unfortunate word, interchangeability.

But the subject must be looked at from a very different point of view when we come to consider the cheaper class of watch; the branch of the trade in which so keen a competition is going on at the present day. Admitting that such a trade is worth preserving, and the statistics already given prove indisputably that it is, the question as to how it may best be fostered becomes a very urgent one, and I would make a few observations bearing upon it. At the outset, however, let me earnestly disclaim any desire to dictate to the trade; watchmakers know the details of their own business best, but what I do wish is to bring the matter more prominently forward, and to urge a more thorough discussion than has yet taken place, as to the reforms that can, with advantage, be introduced into the art, and the points in which we can take advice from our neighbours.

The general depression of trade cannot be held to be solely or even chiefly responsible for the present state of things. Within the last 30 years two new watch-producing countries have practically come into existence. France, although of course the trade has long been established there, has within that period increased its production ten-fold, and in America we have a new competitor. I have already pointed out that, judging from the official returns, we actually export from this country about the same number of foreign watches as of those of home production, whereas the imports for home consumption reach a total of about 250,000, or more than six times the total exports of home and foreign make.

At the risk of being considered a prophet of evil, I venture to refer to the state of the clock trade in this country as bearing on the subject we are considering. Fifty years ago we had a trade in clocks, and no one could have anticipated that, at the present day, it would be practically dead, the only exceptions being turret, regulator, and a few chime clocks, the value of the exports of which amounts to about £50,000. The Continent and America have taken possession of the entire

trade in ordinary timepieces; and in his official report on the 1878 Exhibition at Paris, M. Saunier mentions a fact in relation to it that is well worthy of note. While the production of the higher quality of clocks shows a tendency to fall off, or, at most, to remain stationary, the number of cheap clocks is increasing at a very rapid rate. Whether the same is to be said of watches we have no sufficient means of ascertaining, although the gradual fall in the mean price of English clocks and watches during the years 1867 to 1870, the last for which we have the requisite data, seems to point to some such conclusion; at any rate, it is not safe to hazard a guess as to whether such a tendency would continue: the mere possibility of it, however, indicates the necessity for our doing our utmost to preserve the watch trade intact, and not, as some would advocate, to surrender the cheaper trade without a struggle. At the same time, it is well to observe that there seems good reason to hope for an improvement in the average quality of watches in the future, independently of any advance in the horological art. As the habit of wearing a watch becomes more universal, the desire to possess one of superior quality may be expected to spread in even greater proportion, and the well-known tendency of modern life to make more and more use of our time, necessarily involves greater care in its accurate admeasurement.

I do not pretend to be able to explain the causes which have led to the destruction, more or less complete, of many branches of the horologist's art in this country, but would earnestly commend to all interested in it, the suggestive and most important address, devoted mainly to the subject of foreign competition, which was delivered by the Chairman of the Council of this Society, at the opening of the present Session. We may be sure that Mr. Bramwell had not watchmaking specially in his mind when writing that address; and yet there are many passages in it that might have been intended to have reference to this art. He says:—*

"We shall find, it may be, that many of our industries are carried on according to the old traditions, traditions of practices which were the best known in the days when they were first employed, but which, under the teaching of science in other countries, have been abandoned as obsolete while they are retained by ourselves. We may find, paradoxical as it appears, that the fact of our having been engaged in any particular manufacture for many years obstructs our readily adopting the most improved form of carrying on that manufacture."

And there is one other passage in this address which I cannot refrain from quoting. Speaking of the field of work open to the Society of Arts, the Chairman says:—

"Why should it not put itself in communication with the manufacturers in some industry which is suffering its hold on foreign markets and, it may be, even its hold upon the home market, to be interfered with by the foreigner, to ascertain from these manufacturers whether the competition against them is succeeding on the score of price, or on that of quality, or on the score of the higher knowledge possessed, or the better taste displayed abroad. If it be on account of price, let us find out whether the disparity arises principally from the labour question, or whether it arises, as it must do in countries where labour is dearer than in ours, from the use of improved processes in those countries—processes which we have failed to employ . . . . I have sufficient confidence in the skill and ability, and in the amount of capital available in this country, to believe it needs only that the true causes of the success of our competitors should be discovered, to make us effectually bestir ourselves to restore the threatened industry to its former safe position."

Would not watchmakers have real cause to be grateful if this Society would make their art the subject of investigation as suggested in the paragraph I have just read?

In another part of the same address the claims of Technical Education are brought prominently forward, and I am sure that no one will be prepared to doubt that horology ranks high among those industrial arts that involve the application of science for ensuring any real advance. I shall refer to this subject in the next lecture, and would here only mention that it is one of the 32 trades in which examinations are annually held by the City and Guilds of London Institute for the Advancement of Technical Education.

It is highly improbable that a liberal use of machine-tools should not tend to ameliorate the trade, when there is hardly another trade that has not received invaluable help from them. Any watchmaker can tell for himself, either by examining a movement or such samples as I have here, what degree of assistance it has afforded to the Americans, a people that, prior to about 1850, had no experience of the subject; how much more then should it help us, when we have been pre-eminent as watchmakers for centuries.

When Arkwright patented his "spinning jenny," there was a very great outcry against it, as degrading the manual skill of the workmen; but no such objection can legitimately be made in this case. As I have already been careful to point out, so long as watchmaking exists, it will be impossible to do without a considerable amount of skilled labour in the adjustments, and this would be the case even in the commonest of watches. I am anxious that there should be no doubt whatever on this point, and the most striking example I have been able to adduce consists in a comparison between the prices of two watches manufactured by machinery in America, where, as is generally admitted, its use has been pushed as far as anywhere. They are movements of the same size; the cheaper, approximately adjusted for heat and cold, costs about £12, and the other, more highly finished and adjusted, is quoted at nearly £50, more than four times the price of the first, and yet, to an ordinary observer, such difference as there is would be of comparatively little moment. One may safely assume then that at least half of the price of the higher class watch has been on account of skilled labour. Thus we have no present need to complain that any system has proved itself to be superior to that adopted in this country, so far as regards the best work, and what is now principally needed is that the number of competent workmen should be augmented. Machine work need not, then, degrade the manual skill of our artisans, and the fear that it will necessarily cause the English watch to become less artistic than at present is equally unfounded.

* *Journal of the Society of Arts*, vol. xxix (Nov. 19, 1880), p. 10.

The fact that a particular machine does not produce artistic work is, of itself, no evidence against machinery being able to do so, and there are abundant specimens on the table to show that graceful forms can be secured by such means. Moreover, in the cheapest watch, what is wanted is soundness and good timekeeping, and, if needful, hand labour might be relied on for modifying the form according to taste in the higher grades. But the rapid growth of the production of foreign countries, as compared with our own, if it means anything, must be taken as evidence that the English system of manufacture is not adapted to the cheaper class of watch. If it were, it would be simply impossible that more than a quarter of a million of foreign-made watches should be annually required to satisfy the demands of the home market.

It appears, then, to be a peculiarly convenient time to take a new departure, and if several of the more prominent manufacturers could be induced collectively to take the matter into their consideration, determining how best to systematise the trade, and to take example from our competitors, and if every artisan would lay to heart the lesson which the statistics I have been able to collect teach him, it is impossible but that much good would result.

The various learned societies, the engineering and other professions, keep themselves abreast with the advances made, both at home and abroad, by means of their journals and their periodical meetings; but the horologists of this country, although possessing a monthly journal and a newly-erected institute, must, I think, admit that, as a body, they have not hitherto taken sufficient practical interest in either.

I am very far from denying that many horologists are keenly alive to the necessity of improving the system so that it shall be more in accordance with the requirements of the present day, but their efforts have hitherto failed, owing to the indifference with which every suggestion is received. Their journal and their institute have done unquestionably good work, as a means of instruction, and in keeping those engaged in the art together, by affording them a means of intercommunication; but a far higher work remains to be taken in hand by them, namely, the placing of the entire English trade on a satisfactory footing.

These remarks, although provoked by a consideration of the state of the trade in the cheaper class of watch, cannot but be more or less applicable to the case of higher qualities. At the present day no mechanical art can afford to stand still, and, although the best English watch has maintained its position, even that position is being vigorously assailed from several quarters, and it cannot continue to be held without some effort.

As will be evident from the specimens of machine-work on the table, we already possess in England several factories more or less completely fitted up with machines for the manufacture of watches on the modern system. But the existence of the several establishments to which reference has been made does not disprove that the English system of watchmaking is the hand system, and the problem that now urgently requires solution is how best to benefit those engaged in the manufacture, and, at the same time, to promote the trade of the country. All questions of temporary depression of trade may be laid aside in discussing such a question, for it is a well-known and acknowledged fact, that even in times of commercial prosperity, the trade, taken as a whole, is in an unsatisfactory condition. For years past the cheaper watches sold in this country have been mainly of Swiss and French make, and America is now coming in for a share of the market. And here it may be well to observe that the English makers seem to be unwise in thus neglecting the cheap trade. Preach as you will about the comparative advantages of an English watch, if foreign makers can afford to sell a watch that is a fairly good timekeeper, and often more graceful than that made here for about twice the amount, there can be no wonder if it is in very many cases preferred. The fashion of wearing watches is gradually spreading through lower and lower grades of society, and if the home makers cannot or will not supply this demand, they have no right to complain of other countries taking the matter in hand. And it is unreasonable to suppose that we can hope to permanently retain the higher branches and so consistently neglect the lower. The entire trade is so small in extent that neither portion can afford to dispense with the other; indeed, the lower is, perhaps, of more service to the higher than the higher is to the lower, for, as it becomes more and more general to carry a watch, the inducement to those able to afford one of high quality to become possessed of one is greater; and only those who have tried the experiment know what a real satisfaction there is in being provided with a thoroughly reliable timekeeper.

How then are the interests of this beautiful industry to be best promoted? I do not pretend to be able to answer this question, but there are a few points to which, with your permission, I should wish to draw attention, in the hope that the subject may be earnestly taken up by others. In the first place, it must be admitted that the English system is not calculated to encourage radical improvements. Each workman through whose hands the watch passes is, as a rule, acquainted with only a small proportion of its details, and thus, through being unable to take a general view of the question, is placed in an unfavourable position as an inventor. The watch-jobber, into whose hands the watch comes for repair, stands a better chance of detecting faults of construction, and suggesting a remedy.

The extraordinary amount of independence to which the system has given rise, causes much needless expense and waste of time in the production of a watch. A number of trifling faults are often allowed to accumulate in the watch, each workman apparently leaving a legacy for his successor to correct. Thus it happens that some are sure to be left uncorrected, except in the very best work, and they secure the watch a bad name, if not at once, at any rate after a short time. Of course, on any method of manufacture there would be a risk of some such sources of error, and I am not pretending that these objections are peculiar to the English system. But a discussion lately held at the Horological Institute, at the instance of Mr. Bickley,* seems to show that our system, with careful management, is capable of vast improvement; it is inconceivable that at the present

* *Horological Journal*, xxii., 27.

day so much double work as is done on an English watch is unavoidable.

And one obvious mode of avoiding it, at all events in great part, is the employment of exact machinery to the utmost extent. The most earnest advocate of the hand system cannot but admit that it is responsible for by far the greater number of these irregularities. A man, after making several hundred similar objects, such as screws, may, doubtless, arrive at making them alike by the sole aid of his sight and touch; but this is not true where only a few dozen specimens are made at a time, and they of a more complex form.

But how to popularise the use of machinery is a very difficult question. The factory system would certainly not be welcomed in Clerkenwell. And it may well be doubted whether its introduction would be advisable; the English system has so long consisted in a certain degree of isolation of various branches that efforts should rather be directed towards the improvement of this system, and the setting of it on a more satisfactory footing. Let Prescot retain the movement-making, Coventry the case-making, in addition to its own individual trade of watch-making, Clerkenwell the finishing, escapement-making, &c., but if the trade is to continue a trade, these several branches must work more into each other's hands. It is absurd that one man should systematically be called upon to undo the work of his predecessor, when by proper organisation all such contradiction might easily be avoided. In a watch factory each man, of course, works to a template, and it is surprising that there should be any occasion to advocate its use at the present day, in any of the mechanical arts that involve the production of a number of identical pieces. It is difficult to see why a common standard should not be introduced in the watch trade, and its adoption would constitute a very important step in adapting the English system of manufacture to modern requirements.

We have already seen, from an examination of Prescot movements, how far machinery is employed in what has been termed the "hand system," practised in this country. It is hardly open to question that its use might be extended with very great advantage; and if an accurate system of gauges and standards existed, might not the movement maker carry on the work to a certain definite point, and then hand it over to the Clerkenwell workmen, who would take it up where Prescot left off, without having to do over again any portion of what has already been done well. But it need not necessarily follow that the use of machinery would be confined to the movement-maker.

A principal feature of this system, which stands in the way of any material change, is the great number of small establishments that have to be kept up in Clerkenwell. They not only occasion delay, increase the cost, impede the introduction of improvements, and cramp the abilities of individuals, but they are, in too many cases, utterly unfit for occupation, and cannot fail to have a most detrimental influence on the character of the workman as well as on both the quantity and the quality of his work.

A suggestion recently made by Mr. Glasgow at a meeting of the Horological Institute is worth careful consideration as bearing on this question. Would it not be practicable to establish in Clerkenwell, one or more large shops, where workmen in all the branches of the trade could rent such space as they required? How many advantages would be secured by some such arrangement? They would not only secure a healthy place of business specially adapted to their several requirements, and away from their homes, but would also be brought more in contact with each other and the trade generally. But I venture to think that the scheme might enable them to secure another, and, in some respects, a yet more important advantage; it would immensely facilitate the introduction of modern improvements, both in the watch itself and in the tools employed in its production. Steam power might also be let to the tenants, and there can be little doubt that the possession of it would act as a powerful incentive to the use of tools wherever desirable. Working to the systematic gauges above referred to, the movement might thus be taken in hand as received from Prescot, and pass through the several stages that go to make up the Clerkenwell branch of the trade.

I could not pretend, even if this were a suitable occasion, to follow out the above suggestion into all its details. It is essentially a question for practical watchmakers, and if this or any other scheme, having similar objects in view, have their cordial support, much will have been done to show that we are, to again quote the words of Mr. Bramwell, "effectually bestirring ourselves to restore the threatened industry to its former safe position."

MISCELLANEOUS.

LONDON FISH SUPPLY.

The following statistics relating to the amount of fish brought into London by the various railway companies, have been elicited by the inquiry instituted by the Corporation of London, and now being carried on in the Upper Court, Guildhall.

Mr. W. Birt, general manager of the Great Eastern Railway Company, said his company carried 30,124 tons of fish to Billingsgate last year from various parts of the east and north-east coast. Prime fish at owners' risk, was carried at 32s. 6d. per ton, and offal fish at 21s. 8d. per ton, from station to station. These figures included the market dues, but not the delivery, which, if performed by the company, was charged 5s. per ton extra. It was at the option of the senders whether they sent at their own or the company's risk, although as a fact about 95 per cent. was sent at owners' risk. The company's risk was 6s. 8d. per ton for prime fish, and 3s. 4d. per ton for offal. The difficulties at Billingsgate were very great. A return was made on June 30 this year, when it was found that upon an average each van was delayed four hours at the market. From the experience of his company it appeared to them that two or three markets were needed in London to meet the demands of the fish business of the present day, rather than one central market, and so impressed were they with the necessity of such a change, that in laying out the large works to be constructed at Bishopsgate, they had set aside a. out two and quarter acres of land to be used as a fish market for railway-borne fish. Such a market would save the 5s. now charged for cartage. His company not only proposed to construct the market, but to erect nine warehouses in which the

trade could be carried on. Should an improvement be made in the fish market of London with greater facilities for unloading, and should the supply of fish increase, he had no doubt that his company would reduce their rates.

Mr. J. Noble, general manager of the Midland Railway, said his company carried 9,280 tons of fish to London in 1880. Haddocks and plaice from Hull and Grimsby were charged 35s. per ton; that did not include delivery. Some fish was sent by passenger train, and the extra cost of that was from 6s. to 9s. per ton, according to the kind of fish. The delivery of tanks of fish involved an extra charge of 10s. for cartage. Replying to questions, the witness said his company had a quantity of land at their disposal at St. Pancras, and he had thought of allocating a portion of it as a fish market. He was in favour of a large central market easy of access.

Mr. H. Oakley, general manager of the Great Northern Railway Company, said his company conveyed 26,543 tons of fish to Billingsgate last year. The rates varied from 30s. to 70s. for coarse fish from Scotland. The average rate for prime fish was 46s. 8d. from Hull and Grimsby. The greatest difficulty was experienced near Billingsgate in getting vans up to the market. They allowed three hours and a-half for their vans to deliver the fish at the market, but, as a rule, it occupied between six and seven hours, and sometimes 10 hours. In fact, it took as long for a van to go from King's-cross, deliver the fish, and return, as it did to convey the fish by train 200 miles through the country. The rates he had quoted did not include delivery, for which a charge of 5s. was made. A central market with streets running through it, and easy of access, would be very desirable in the interest of both buyer and seller.

Mr. D. Stevenson, traffic superintendent of the London and North-Western Railway, said that about 8,089 tons of fish were conveyed by his company to Billingsgate last year. The rate from Scotland was 75s. per ton by passenger train and 55s. per ton by goods train. For goods by passenger trains an extra charge of from 4s. to 5s. was made. To make Billingsgate large enough, it would be necessary to throw into it the uncovered land of the Custom House on the one side, and on the other the land covered by Nicholson's wharf, up as far as London-bridge. He thought there might be two markets, one for water and the other for railway borne fish. The charge for the carriage of fish was three or four times as much as was paid for iron. Meat from Liverpool was charged 25s. per ton, while fish from Holyhead was 55s.; that was on account of the risk attached to the carrying of fish.

Mr. H. Lambert, chief goods manager of the Great Western Railway, said that his company conveyed 6,724 tons of fish to Billingsgate last year. The cost of conveyance from the West of England was 60s. per ton, and from New Milford 65s. 6d. All fish trains ran at high speed, and the company undertook to supply a special train within three hours whenever the senders had a supply of 20 tons weight. Although quickly brought to London, it often took from four to eight hours to get it delivered at the market. He did not believe the present market, however much improved, could be made a suitable market for all London.

Mr. Mortimer Harris, manager of the London, Chatham, and Dover Railway, said that his company conveyed 2,530 tons of fish to Billingsgate in 1880, for which they charged a rate of 22s. per ton for coarse fish, and 40s. for other sorts. He was favourable to the establishment of several markets in the metropolis situate near the railway termini.

Mr. J. Light, goods manager of the South-Eastern Railway Company, said that 3,071 tons of fish were carried by his company last year. The rates from Hastings were, for prime fish, 40s. per ton; and 22s. 6d. for coarse fish.

Mr. Arthur Johnson, fish meter, was examined, and said that his duty was to inspect all the fish as it came on the vans, and also by boat, into the market. The quantity which was received could not be given accurately, as it varied each month. Sometimes 500 tons would arrive, other days 830 tons would be received. The average quantity sent to Thames-street, Billingsgate, and into the market, was 1,700 tons per month altogether. During the last six months, from the 1st of January to the 30th of June, the quantity condemned was forty tons per month, of which one-third was shell fish and the other wet fish, such as plaice and haddocks. If the market had been ten times the size it was, it would have made no difference, as a large quantity of the fish so condemned was seized in the railway vans. The delay in the vans could not be helped. The fish was condemned chiefly between six and seven in the morning, when it came into the street. The bulk of the fish was condemned on the Monday, which was on account of its being delayed on the Sunday. That would happen in any market. He was of opinion that the fish condemned on Monday was bad before it left the railway station. They threw the condemned fish into tanks filled with acid. While this condemned fish was being unloaded the space in the street was being taken up, and prevented the business going on until it was cleared away. He was authorised by the Fishmongers' Company to seize fish on his own responsibility. It was not always necessary to call in another inspector before condemnation. The quantity of fish coming by water varied very much.

This subject of fish supply is one in which the Society of Arts has always exhibited the greatest interest. As early as 1761 the Society advanced the sum of two thousand pounds to Mr. John Blake, for the purpose of carrying out his scheme for the supply of the markets of London and Westminster from distant sea ports and rivers by land carriage. During the last few years the subject has been considered by the Food Committee.

PANAMA CANAL.

A correspondent of the *Journal des Débats*, writing from Panama, gives an account of the progress made thus far with M. de Lesseps' great undertaking. The first practical work of any importance yet completed, is the construction of a grand pathway from Colon to Panama, which has been cleared of trees and other obstructions to a width varying from 30 to 60 feet. Now that this clearance has been effected, it is possible for the first time to get a clear idea of the work which is before the company. Hitherto, it has been only by rather vague guesses that the lie of the surface could be conjectured, inasmuch as the thick foilage of the trees, spreading over the valleys and ravines, often made it difficult even to see that these existed. If it was assumed, as the *Débats* thinks, that in these cases the ground was as flat as the tops of the trees, then the discovery of deep depressions so arched over will be a great gain in estimating the extent of the excavation works. There is, however, another point in which the most recent explorations are regarded as unexpectedly favourable. It was assumed when the plans were made that all along the route of the projected canal a stratum of hard rock would be found underlying the soil at a depth of about twelve feet. But at Emperador, where the principal borings have been made, it is stated that on March 31 the instrument had reached a depth of 37 feet without finding any rock, and even at that point the rock which appeared was only a layer about six feet thick, succeeded underneath by a mixture of clay and soft stone, which went down to a depth of 64 feet, where the bore was still working lately without encountering any rock. It is now said that the excavation works will be begun about October next, after the rainy season, and in the meantime the preparatory

operations are being actively carried on by companies of workmen, recruited from amongst the inhabitants and from Carthagena, whence they have been driven by an invasion of locusts.

NOTES ON BOOKS.

Suggestions in Design, being a Comprehensive Series of Original Sketches in Various Styles of Ornament, arranged for application in the Decorative and Constructive Arts. By John Leighton, F.S.A.; with descriptive and historic letter-press by James K. Colling. London: Blackie and Son. 4to.

As long ago as 1852, Mr. Leighton published a work with the same title, under the *nom de plume* of Luke Limner, which contained the nucleus of the present book in the shape of 47 plates. The author has revised and re-drawn these, and added more than an equal number of fresh illustrations. The object is to present a large series of designs conceived in the spirit of a considerable variety of styles of art, which may be useful to artists. These plates "are intended as aids to design rather than for servile imitation or direct appropriation, serving to represent the type of many designs, and not the exact portraits of any. The object of the author, therefore, being to present suggestions, leaving the designer or art workman to modify or adapt them to his own purposes, it is hoped that the book will be found eminently suited to the wants of all engaged in decorative and ornamental work." The subjects are arranged in the following order:—First, those of general periods and nationalities—Savage tribes, Egyptian, Assyrian, Greek, Etruscan, Pompeian, Roman, Chinese, Japanese, Indian, Persian, Moorish, Byzantine, and Gothic. The Renaissance is seen in some of its various developments, then more special conceptions are shown in floral decorations, figures, chimeras, &c. Designs for metal work, inlaying, blazonry, &c., are also given. In the descriptive letterpress, the various points, as shown in the plates, are taken up *seriatim*, and the general principles of design have a special chapter devoted to their discussion.

A Practical Treatise on Coach-Building—Historical and Descriptive. By James W. Burgess. London: Crosby Lockwood and Co. 1881.

The author affirms that it is over fifty years since an exhaustive book on the trade of coach-building has been published, and he has, therefore, attempted in this handbook to point out the general principles upon which carriages should be constructed. The first chapter is devoted to a general history of the subject, from the Egyptian war chariot to the carriages of to-day. The various parts of a carriage, the painting, the lining, &c., are treated of in subsequent chapters. In the general remarks on the trade, a hopeful view is taken of the increased skill and ingenuity of the coach workman, and the author alludes to the beneficial influence of the Exhibitions of the Coachmakers' Company.

The Diamonds, Coal, and Gold of India, their mode of Occurrence and Distribution. By V. Ball, M.A. London: Trübner and Co. 1881.

Mr. Ball designs his book as a hand-book to the detailed accounts of the more useful mineral deposits of India, published by the Geological Survey of India and other authorities, the results of which thorough explorations have not hitherto, he believes, been introduced into text-books. With regard to diamonds, he believes the Koh-i-nur to be identical with the Great Mogul diamond described by Tavernier, which came from Kollur. The author is of opinion that there is not the least ground for supposing that the localities where mining is possible have been exhausted, and he thinks that if Europeans would undertake diamond mining in India, they would find it profitable. Of the other two subjects treated of in this book, the author gives an account of the various coal-fields distributed over the whole of India, and of the gold-producing tracts, which consist of Wynaad and Kolar, in Madras; Dharwar, Belgaum, and Kaladgi, in Bombay; Central Provinces, Orissa, South-West Bengal, North-West Provinces, including Himalayas and Punjab; and Ultra-peninsular areas, such as Assam, Burmah, Afghanistan, and Thibet.

Sketches in Water Colors. By Various Artists. (Vere Foster's Drawing Books, Extended series.) London: Blackie and Son. Three parts, 4to.

These sketches consist of chromo-lithographs of drawings, by F. M. Richardson, R.P. Leitch, J. A. Houston, F. L. Rowbotham, E. Duncan, and J. Needham; and full directions are given as to the way in which they may best be copied by the learner.

Easy Studies in Water Color Painting. By R. P. Leitch and J. Callow. London: Blackie and Son.

The nine chromo-lithographs here given are intended for the use of those students who have already attained proficiency in pencil drawing, and wish to obtain a knowledge of the art of landscape painting in water-colours.

GENERAL NOTES.

Institution of Mechanical Engineers.—The summer meeting of the institution will be held this year at Newcastle-on-Tyne, from Tuesday, 2nd, to Friday, 5th August. There will be excursions on each day, and a large number of Works will be open for the inspection of members. The Secretaries' office will be open on Monday, at the Wood Memorial Hall, Newcastle-upon-Tyne.

Technological Hand-books.—Messrs. George Bell and Sons are preparing for publication a series of Technological Hand-books for the use of candidates in the Technological Examinations, which, instituted by the Society of Arts in 1873, were, in 1879, transferred to the City Technical Institute. The rapid increase in the number of candidates since the examination scheme was remodelled, and since the examinations have been supported by the friends of the associated Guilds, is considered to justify the expectation that these hand-books will be successful, since it shows that there are many artisans and others who are seeking to make themselves familiar with the theory of their special industries. It is intended by the publishers eventually to include in the series all the industries specified in the programme of the City Institute; but at first those branches of manufacture have been selected for treatment in which it appears that text-books are most required. In accordance with this idea six books are now announced for publication:—"Calico Bleaching, Dyeing, and Printing, by William Crookes, F.R.S., V.P.C.S.; "Iron and Steel Manufacture," by A. K. Huntington, F.C.S., F.I.C., Professor of Metallurgy at King's-college, London; "Telegraphs and Telephones," by W. H. Preece, F.R.S., Memb. Inst. C.E., Electrician to the General Post-office; "Cotton Manufacture." Part I, Spinning; Part II, Weaving; by R. Marsden, Editor of the *Textile Manufacturer*. "Glass Manufacture." Crown, Sheet, and Plate Glass, by Henry Chance, M.A. (Chance Bros., Birmingham); Flint Glass, by H. Powell, B.A. (Whitefriars Glass Works); Optical and Lighthouse Glass, by John Hopkinson, M.A., LL.D., F.R.S. The series is issued under the general editorship of H. Trueman Wood, the Secretary to the Society of Arts.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, is now open daily. A non-transferable season ticket will be sent to any member of the Society on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

PATENT-LAW AMENDMENT.

The Committee appointed for the purpose by the Council have prepared a draft Bill, which has been submitted to the Council and approved by them.

In accordance with the instructions of the Council, this Bill is now published for the consideration of the members and of the public, as being the first draft of a Bill which, in the opinion of the Council, embodies the essential provisions of a comprehensive Patent-law.

The Council will summon a public meeting in the autumn for the discussion of the Bill, after which measures will be taken to obtain its introduction into Parliament, in the Session of 1882.

The following is a list of the Committee by whom the Bill has been prepared:—Sir Frederick Bramwell, F.R.S. (Chairman); F. A. Abel, C.B., F.R.S.; Alfred Carpmael; Sir Henry Cole, K.C.B.; Captain Douglas Galton, C.B., F.R.S.; W. H. Perkin, F.R.S.; C. W. Siemens, LL.D., F.R.S.; and H. Trueman Wood (Secretary).

The Secretary will be glad to receive from members of the Society and others any observations or comments on the Bill which they may think fit to send for the consideration of the Committee.

The Bill has been printed in the usual form, and copies can be had on application at the Society's office, price 6d.

H. Trueman Wood, *Secretary.*

The following is the full text of the Bill:—

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DRAFT OF A BILL TO CONSOLIDATE WITH AMENDMENTS THE LAW CONCERNING LETTERS PATENT FOR INVENTIONS, AND FOR OTHER PURPOSES.

Whereas it is highly important, for the good of the Arts Manufactures and Commerce of this realm, that new and meritorious inventions should receive all possible assistance and encouragement;

And whereas the existing law does not sufficiently secure property in an invention to its true inventor, or offer him such encouragement as may induce him to develop his invention for the public benefit, and is in other respects defective and ill-calculated to promote the progress and use of such inventions as aforesaid;

And whereas it is therefore expedient that the law concerning Letters Patent for Inventions be amended and consolidated;

Be it enacted by the Queen's most Excellent Majesty by and with the advice and consent of the Lords Spiritual and Temporal and Commons in this present Parliament assembled and by the authority of the same as follows:

PART I.

Preliminary.

1.—(1.) This Act may be cited as the Patents for Inventions Act 188 .

(2.) This Act extends to the Channel Islands and to the Isle of Man.

(3.) This Act comes into operation (except where it is otherwise expressed) on the *first* day of *January* 188 , which time is herein referred to as the commencement of this Act.

2. The Acts described in the First Schedule to this Act are hereby repealed as from the commencement of this Act to the extent in that Schedule mentioned.

All rules and regulations made under any of the enactments repealed by this Act are also hereby repealed as from the commencement of this Act.

3. In this Act—

"The Statute of Monopolies" means the Act of the twenty-first year of the reign of King James the First, chapter three, intituled An Act concerning Monopolies and Dispensations with Penal Laws and the Forfeiture thereof:

"Invention" means anything which may be the subject of the grant of a patent under this Act, and includes an alleged invention:

An invention is deemed new for the purposes of this Act if it has not been published or publicly used in the United Kingdom the Channel Islands or the Isle of Man, within the *thirty* years immediately preceding the date of the application for the patent for it:

"Patent" means letters patent for an invention:

"Applicant" means applicant for a patent:

"Patentee" means the grantee of a patent, and includes his executors administrators and assigns:

"Examiner" means an Examiner of Patents under this Act:

"Commissioner" means a Commissioner of Patents under this Act:

"Expert" means a person specially qualified by his knowledge of manufactures or science or arts to assist the Commissioners of Patents in the case in which his assistance is sought:

"Abroad" means out of the United Kingdom the Channel Islands and the Isle of Man:

"The Treasury" means the Commissioners of her Majesty's Treasury or two of them:

"The High Court of Justice" means her Majesty's High Court of Justice in England or Ireland, as the case may require:

"Prescribed" means prescribed by general rules made by the Commissioners of Patents under this Act:

For the purposes of this Act a year in relation to a patent is reckoned as beginning on the day, or the anniversary of the day, of its date, and ending at the end of the day next before the anniversary of the day of its date.

(i.)—*Exception from Statute of Monopolies.*

4. All patents duly granted under this Act are hereby excepted from the operation of the Statute of Monopolies, and shall not be invalidated or affected by anything therein contained.

(ii.)—*Subject Matter of Patents.*

5. A patent may be granted under this Act for—

(*a.*) Any manufacture or any product not being a natural product;

(*b.*) Any machine or any means of producing any manufacture product or result;

(*c.*) Any process or method of producing any manufacture product or result;

(*d.*) Any part of a machine means process or method of producing any manufacture product or result.

6.—(1.) A patent may be granted to any person, whether a British or foreign subject, declaring himself to be the inventor of an invention within the meaning of this Act, or to his executors administrators or assigns or to his or their attorney or agent, subject to the provision made by this Act for inventions patented abroad.

(2.) Where two or more persons declare themselves to be the joint inventors of an invention within the meaning of this Act, a patent may be granted to them in their joint names, subject to the like provisions as in the case of a single patentee

7.—(1.) Where a grant of privilege has been made by letters patent or otherwise for the monopoly or exclusive use or exercise abroad of an invention, a patent for that invention can only be granted to the foreign or colonial grantee, or his legal personal representative (by himself his attorney or agent); and can only be granted to him on his written application within *twelve* months from the date of the foreign or colonial grant, or of the earliest of them if more than one, or where the same is or are existing at the commencement of this Act, then within *twelve* months after the commencement.

(2.) The patent if granted, shall not be affected by the publication of the invention in the United Kingdom the Channel Islands or the Isle of Man by means only of the circulation or republication therein within those *twelve* months of copies of any foreign or colonial grant in respect of the invention or of any specification or other document connected with that grant.

(3.) The patent if granted shall not be affecte

as to duration or otherwise by the expiration or determination in any other manner of the foreign or colonial grant.

(iii.)—*Commissioners of Patents and Examiners.*

8.—(1.) There shall be a Board of Commissioners of Patents for Inventions, in this Act referred to as the Commissioners:

(2.) At any time after the passing of this Act her Majesty may, by warrant under the Sign Manual, appoint three persons to be Commissioners, of whom one shall be experienced in engineering, one shall be experienced in chemistry, and one shall be experienced in the law:

(3.) On the occurrence of any vacancy her Majesty may from time to time in like manner appoint a person of qualifications similar to those of the vacating Commissioner to fill the vacancy:

(4.) The Commissioners shall have an official seal, and impressions thereof shall be judicially noticed and admitted in evidence.

9.—(1.) The Commissioners may from time to time after the passing of this Act, subject to the approval of the Treasury, appoint such persons qualified by knowledge of manufactures or science or arts, as they see fit, to be Examiners of Patents.

(2.) The instrument of appointment shall in each case state the opinion of the Commissioners that the person appointed is so qualified.

(iv.)—*Application for Patent.*

10.—(1.) An applicant for a patent must lodge at the Patent-office an application and declaration in the prescribed form, accompanied by a specification describing the nature of the invention (in this Act termed the Provisional Specification).

(2.) Notice of the application, but not of the contents of the provisional specification, shall be published by the Commissioners.

(3.) On the grant or refusal of a patent, or on failure to prefer a request for sealing within the time allowed, the provisional specification shall be destroyed in the Patent-office; and until it is so destroyed its contents shall be kept secret.

11. The publication or public use of the invention after the application and within a period of *nine months* from the date of the application shall not prejudice the grant of a patent for the invention (which protection from the consequences of publication or public use is in this Act referred to as Provisional Protection).

12.—(1.) The application and its accompanyiug documents shall be referred by the Commissioners to an Examiner, who shall report to them his opinion—

(*a.*) Whether the invention is subject-matter for a patent;

(*b.*) Whether the title of the invention sufficiently indicates its nature, and whether the provisional specification is in accordance with the title.

(2.) A copy of the report shall be furnished to the applicant, and he may within the prescribed time appeal to the Commissioners against it.

(3.) If the Examiner reports against the title and the provisional specification or either of them, and his report is not appealed against, or is affirmed on appeal, the application shall not be further proceeded with, unless the applicant within the prescribed time amends the title or provisional specification as the case may be to the satisfaction of the Commissioners.

(4.) If the Examiner reports that the invention is not subject-matter for a patent, the application may, notwithstanding that his report is affirmed on appeal, be proceeded with; but in that event every copy of the patent if granted and every office copy of the specification shall bear on it a short statement of the report of the Examiner.

13.—(1.) At any time during, and not less than *three* months before the expiration of, the period of provisional protection, the applicant may lodge at the Patent-office a further specification, particularly describing and ascertaining the nature of the invention and in what manner it is to be performed (in this Act termed the Complete Specification or the Specification) together with a written request for the sealing of the patent.

(2.) If he fails to do so, the provisional protection shall cease and the application shall not be proceeded with, save by special leave of the Commissioner, on proof to their satisfaction of reasonable excuse for the failure.

14.—(1). The applicant may, if he thinks fit, instead of lodging a provisional specification lodge a complete specification and request for sealing, with his application and declaration in the first instance.

(2.) In that event the provisions of this Act relating to the provisional specification and to provisional protection shall not apply.

15.—(1.) On the lodging of the complete specification the Commissioners shall again refer the case to an Examiner.

(2.) The Examiner shall report to the Commissioners his opinion—

(*a.*) Whether the complete specification is in accordance with the title and with the provisional specification (if any); Provided that that the applicant shall be allowed, at any time before the Examiner reports, to modify his complete specification by omitting therefrom any matter contained in the provisional specification.

(*b.*) Whether the claim of the applicant is defined with sufficient clearness.

(3.) A copy of the report shall be furnished to the applicant, and he may within the prescribed time appeal to the Commissioners against it.

(4.) If the report of the Examiner on any question submitted to him is adverse to the applicant and is not appealed against or is affirmed on appeal, the application may nevertheless be proceeded with; but in that event every copy of the patent if granted and every office copy of the specification shall bear on it a short statement of the report of the Examiner.

16. The Commissioners shall publish the complete specification as soon as may be after it is finally settled, and thereupon for the residue of the period of provisional protection, or (where no provisional specification has been lodged) for *nine* months after lodging the complete specification the applicant shall have the like privileges and rights as might have been conferred by a patent for the invention sealed as of the date of the application.

17.—(1.) The Commissioners shall publish notic

of the time appointed by them for considering the grant of a patent.

(2.) Any person may, within the prescribed time, give notice to the Commissioners of his intention to oppose the grant, on the ground of the applicant having obtained the invention from him, but on no other ground.

(3.) The Commissioners shall hear such person, if in their opinion entitled to be heard, as well as the applicant, before the expiration of the period of provisional protection, or (where no provisional specification has been lodged) of the *nine* months after lodging the complete specification.

18. If the decision of the Commissioners is in favour of the grant, the Commissioners shall cause to be made out and sealed with their seal a patent in the form in the second schedule to this Act, or in such other form as may be prescribed.

19.—(1.) Every patent shall be dated the day of application for it [save that, where the Commissioners so direct, a patent may be dated the day of the sealing, or any day between the day of the application and the day of sealing.]

(2.) Every patent shall be sealed as of the day of its date.

(3.) But it shall not be competent for the patentee to take any proceeding in the respect of an infringement of the patent committed before the publication of the complete specification.

20. The term limited in every patent for the duration thereof shall be *seventeen* years from its date.

21. Every patent when sealed shall have effect throughout the United Kingdom the Channel Islands and the Isle of Man.

22.—(1.) Every patent shall notwithstanding anything therein or in this Act, cease at the end of the *fourth* or the *eighth* year of its term, unless in the *fourth* and in the *eighth* year respectively of its term the patentee takes out at the Patent-office a certificate of renewal which shall be granted on his request in writing.

(2.) If, nevertheless, in any case, by accident mistake or inadvertence, the patentee fails so to take out a certificate of renewal, he may prefer a request to the Commissioners for an enlargement of the time for taking it out.

(3.) Thereupon the Commissioners may if they think fit enlarge the time accordingly, but not in any case so as to extend beyond *six months* from the end of the *fourth* or the *eighth* year aforesaid (as the case may be).

(4). No proceeding shall be taken in respect of an infringement committed within the enlarged time, save by special leave of the Commissioners.

(v.)—*Amendment of Specification.*

23.—(1.) An applicant for a patent or patentee may prefer a written request to the Commissioners for leave to amend his complete specification by way of explanation or disclaimer, stating reasons for his request.

(2.) The request shall be published by the Commissioners, and the applicant or patentee shall be heard in support thereof by an Examiner, or the Commissioners, in the prescribed manner.

(3.) The request shall be granted by the Commissioners on their being satisfied that the amendment will not make the specification comprise an invention substantially larger than or substantially different from the invention originally claimed.

(4.). Any person giving notice within the prescribed time to the Commissioners of objection to the amendment on the ground that it would make the specification comprise an invention substantially different from the invention originally claimed, shall be heard in support of his objection.

(5.) An amendment shall not be admissible in evidence in a proceeding for an infringement alleged to have taken place before an amendment, nor in any proceeding pending at the time of request for leave to amend, except a proceeding for revocation of the patent.

(6.) Leave to amend shall be conclusive as to the right of the party to amend, except in case of fraud.

(vi.)—*Prolongation of Patent.*

24.—(1.) A patentee may within the prescribed time before the expiration of his patent apply to the Commissioners for a prolongation of its term:

(2.) The Commissioners shall publish notice of the application, and of the time fixed for hearing it:

(3.) Any person interested (including a representative of the Crown if interested but not otherwise) may on giving the prescribed notice to the patentee appear at the hearing and oppose the application:

(4.) The decision of the Commissioners on the right, (if challenged) of any person to appear, is final.

25.—(1.) The Commissioners after hearing the case may refuse the application, or may order the prolongation of the term of the patent for any period not exceeding *eleven* years, as they may see fit:

(2.) In determining the case the Commissioners shall have regard to all the circumstances, and in particular to the merit and utility of the invention, to the patentee's expenditure of labour and money, and to the amount of his profits as patentee, considered in relation to the benefit derived by the public:

(3.) It shall not be competent for the Commissioners to impose any conditions in respect of an order for prolongation:

(4.) The order shall be endorsed on or annexed to the patent, and the term of the patent shall be prolonged accordingly.

(vii.)—*Stamp Duties.*

26.—(1.) There shall be paid to and for the use of the Crown on the several instruments described in the *third* schedule to this Act the Duties in that schedule mentioned and no others:

(2.) Those duties shall be under the management of the Commissioners of Inland Revenue, and shall be deemed stamp duties within the Stamp Duties Management Act 1870 and other Acts relating to stamp duties, particularly those relating to forgery fraudulent dies and other offences in connexion with stamp duties:

(3.) Any of the stamps may be adhesive if the Treasury think fit.

(viii.)—*Crown.*

27.—(1.) A patent shall have to all intents the

like effect as against her Majesty the Queen her heirs and successors as it has as against a subject :

(2.) But for purposes of the naval or military service of the Crown one of her Majesty's principal Secretaries of State or the Lords Commissioners of the Admiralty may, by their officers agents contractors or others, at any time after the application for the patent, use the invention on terms to be before or after the use thereof agreed on, with the approval of the Treasury, between some duly authorised representative of the Crown and the patentee, or in default of such agreement to be settled by the Commissioners after hearing the representative of the Crown and the patentee, if desirous respectively of being heard :

(3.) All expenses of the hearing shall be paid as part of the expenses of the Commissioners in the execution of this Act.

(ix.)—*Assignment and Licenses.*

28. A patentee may assign his patent for England, or for Scotland, or for Ireland, as effectually as if the patent were originally granted to extend to England only or to Scotland only or to Ireland only.

29.—(1.) On complaint and proof to the satisfaction of the Commissioners—

That by reason of default of the patentee to grant licenses or otherwise, the reasonable requirements of the public with respect to his invention cannot be supplied ; *or*

That any person is in possession of an improvement on the invention which he is prevented from working or using, by reason of the patentee refusing to grant him a license on reasonable terms ;

Then and in either of such cases the Commissioners may, on the application of any person interested, order the patentee to grant licenses on such terms as to amount of royalties, security for payment, leave to the patentee to use any improvement, and otherwise, as to them, having regard to the nature of the invention and to all the circumstances of the case, may appear just.

(2.) On complaint and proof to the satisfaction of the Commissioners that a patentee has failed to comply with an order made under this section, the Commissioners may, if they think fit, after hearing the patentee if desirous of being heard, either require him to give security for his compliance, or may revoke his patent without prejudice to the rights of existing licensees.

[(3.) But the patentee may, if he thinks fit, in lieu of granting licenses pursuant to an order of the Commissioners, require any applicant for a license to purchase all his rights under the patent at a price to be fixed in default of agreement by the Commissioners.]

(x.)—*Registers of Patents and Proprietors.*

30. There shall be kept at the Patent-office a book or books called the Register of Patents, wherein shall be recorded in chronological order all patents granted under this Act, the lodging of specifications amendments of specifications certificates of renewal prolongations of patents the expiration or revocation of patents, with the dates thereof respectively, and such other matters concerning patents as the Commissioners direct.

31.—(1.) There shall be kept at the Patent-office a book or books called the Register of Proprietors, wherein shall be recorded any assignment of a patent or of any share or interest therein, and any license under a patent and the expiration thereof.

(2.) Until an entry of an assignment of a patent, or of any share or interest therein or an entry of a license under a patent, is made in the Register of Proprietors, the original patentee shall be deemed to be the sole proprietor of the patent, and not to have granted any license thereunder.

(3.) An entry in the Register of Proprietors shall be proof of the assignment or license or proprietorship, as therein expressed, until the contrary is proved.

32. The Register of Patents and the Register of Proprietors, or copies thereof respectively shall be open to public inspection, on payment of a fee not exceeding *one shilling*, and subject to any regulations made by the Commissioners.

33.—(1.) The High Court of Justice in England, or a judge thereof, may at the instance of any person deeming himself aggrieved by any entry made under colour of this Act in the Register of Patents or the Register of Proprietors, make such order for expunging or varying that entry, and with respect to the costs of the proceedings as the court or judge thinks fit :

(2.) The entry shall be expunged or varied accordingly.

(xi.)—*Revocation of Patents.*

34. The proceeding by *scire facias* to repeal a patent is hereby abolished.

35.—(1.) A patent may be revoked by the Commissioners on the petition of any person interested on any of the following grounds :—

(*a.*) That the invention is not new within the meaning of this Act;

(*b.*) That the patentee is not the true inventor ;

(*c.*) That the specification is insufficient or misleading :

(2.) Where a patent has been found invalid by the Commissioners in a proceeding for infringement, it shall, unless within the prescribed time the ground of invalidity is removed by amendment of the specification, be revoked by the Commissioners.

36. Where a patent for an invention obtained in fraud of the true inventor is revoked by the Commissioners on the petition of the true inventor, the Commissioners may, if they see fit give the true inventor his costs of the hearing as between solicitor and client.

(xii.)—*Foreign Vessels.*

37.—(1.) A patent shall not prevent the use of an invention for the purposes of the navigation of a foreign vessel within the jurisdiction of any of Her Majesty's Courts in the United Kingdom, or the use of an invention in a foreign vessel within that jurisdiction, provided it is not used therein for or in connexion with the manufacture or preparation of anything intended to be sold in or exported from the United Kingdom :

(2.) But this section does not extend to vessels of any foreign State in whose territories British subjects do not enjoy equal benefits in respect of the subject-matter of this section.

(xiii.)—*Industrial and International Exhibitions.*

38. The publication or use of an invention at any industrial exhibition or at any international exhibition for the purposes of such exhibition and within the place where it is held shall not, nor shall the publication or use elsewhere by any person without the consent and privity of the inventor, be deemed a publication or use so as to prejudice the right of the inventor his executors administrators or assigns to lodge an application for a patent for the invention at any time within *eighteen months* after the opening of the exhibition, nor invalidate any patent that may be granted for the invention.

In and for the purposes of this section the expression industrial exhibition has the same meaning as the Industrial Exhibitions Act, 1865: the expression international exhibition has the same meaning as in the Protection of Inventions Act, 1870.

(xiv.)—*Fraud. Offences.*

39. A patent granted to the true inventor shall not be invalidated by an application in fraud of him or by provisional protection obtained thereon, or by any publication or use of the invention consequent on that fraudulent application.

40. If any person makes or causes to be made a false entry in the Register of Patents or in the Register of Proprietors, or a writing falsely purporting to be a copy of an entry therein, or produces or tenders or causes to be produced or tendered in evidence any such writing knowing the entry or writing to be false, he shall be guilty of a misdemeanour.

41. In each of the following cases, that is to say—

(*a.*) If any person writes paints prints moulds casts carves engraves stamps or otherwise marks on anything made used or sold by him in respect whereof he has not a patent, the name or any imitation of the name of any other person who has a patent in respect thereof, without the leave in writing of the patentee;

(*b.*) If any person, or any such thing, not having been purchased from the patentee or from some person who purchased it from or under the patentee, or not having had the license or consent in writing of the patentee, writes paints prints moulds casts carves engraves stamps or otherwise marks the word Patent or the words Letters Patent, or any words of the like kind or meaning, with a view of imitating or counterfeiting the stamp mark or other device of the patentee, or in any other manner imitates or counterfeits the stamp mark or other device of the patentee;

Every such person shall for every such offence be liable to a penalty not exceeding *fifty pounds*, to be recovered by action or other proceeding or information in the High Court of Justice, one-half thereof to be paid to the Treasury, for the use of the public, and the other to the person who sues.

42. If any person wilfully and corruptly lodges or causes to be lodged at the Patent-office any prescribed declaration knowing it to be untrue in any material particular, he shall be guilty of a misdemeanour.

(xv.)—*Supplemental as to Procedure.*

43.—(1.) The Commissioners and Examiners may for purposes of this part of this Act administer and take or cause to be administered and taken oaths and declarations:

(2.) If any person in any testimony given on oath or affidavit or in any declaration made under this section wilfully and corruptly makes a statement false in any material particular, he shall be guilty of perjury.

44.—(1.) Notwithstanding anything in this Act, an applicant for a patent may from time to time obtain from the Commissioners, if and as far and on such terms (if any) as the Commissioners think fit, and whether the original period is expired or not, an extension of the period of provisional protection, not exceeding *twelve months* in the whole from the date of the application for the patent.

(2). In every such case everything done or happening within the extended period shall have effecct as if it had been done or had happened within the period originally allowed.

45.—(1.) Where the Commissioners or an Examiner hear an opponent, they or he may if they or he think fit direct by and to whom the costs of the hearing and proceedings connected therewith or any part thereof shall be paid, and how and by whom the amount thereof shall be ascertained.

(2.) If any costs so directed to be paid are not paid within *four days* after service of notice of the amount thereof so ascertained on the party liable to pay the same, the Commissioners may make an order for payment thereof, and that order may be made a rule of the High Court of Justice.

(3.) This section does not extend to empower the Commissioners to direct the costs of opposition to an application for prolongation to be paid by the patentee, in the absence of fraud or misconduct on the part of the patentee.

46.—(1.) An opponent of the grant of or of the amendment of a patent, and an applicant for revocation of a patent, must deliver the prescribed particulars of the objections on which he relies.

(2.) Evidence in proof of an objection of which particulars have not been delivered is not admissible, save by leave of the Examiner or Commissioners hearing the case.

(3.) Particulars delivered may be from time to time amended by leave of the Examiner or Commissioners hearing the case.

47.—(1.) On any opposition to grant of a patent and on any petition for revocation of a patent, the Commissioners may, and on the request of either party shall, obtain the assistance of an expert as assessor.

(2.) In appointing an assessor the Commissioners shall have regard to the wishes of the parties, if they agree.

(3.) The duty of an assessor is to give his opinion on any question at the request of the Commissioners, and on any other question which he deems important for the decision of the case, but he has no voice in the decision.

(4.) The remuneration of an assessor may be paid as part of the expenses of the execution of this Act, or by the parties as part of the costs of the proceedings, or partly in one way and partly in the other, as may, subject to general rules, be directed by the Commissioners.

(xvi.)—*Supplemental as to Commissioners.*

48.—The Treasury shall provide an office for the Commissioners called the Patent-office, with a museum and library, and any other buildings that may be requisite for purposes of this Act.

49. There shall be paid out of money provided by Parliament to each Commissioner such yearly salary not exceeding [ ] and to the Examiners such yearly salaries not exceeding in the case of any Examiner [ ] as the Treasury determine.

50.—(1.) The Commissioners may from time to time after the passing of this Act, subject to the approval of the Treasury, appoint so many clerks and officers as they think fit, and may, from time to time remove any of those clerks and officers.

(2.) The salaries of those clerks and officers shall be fixed by the Commissioners subject to the approval of the Treasury, and the same and the current and the incidental expenses of the Commissioners in the execution of this Act shall be paid out of money provided by Parliament.

51. The Commissioners may at any time after the passing of this Act and from time to time (subject to the provisions of this Act) make vary and rescind general rules for prescribing and regulating—

- (*a.*) The form and contents of applications specifications drawings declarations objections certificates reports amendments patents and other documents, and of copies and extracts, and the lodging making recording issuing publishing and inspecting, and otherwise proceeding on and dealing with the same or any of them;
- (*b.*) The evidence and procedure on hearing applications oppositions and petitions for prolongation or revocation;
- (*c.*) The advertisement in a journal to be published periodically by the Commissioners or otherwise, of all matters whereof notice is required to be published by the Commissioners under this Act;
- (*d.*) The keeping of the Register of Patents and of the Register of Proprietors:
- (*e.*) The opening to public inspection, and the publication and sale of copies of specifications drawings models amendments reports and other papers.
- (*f.*) The presentation of copies of the publications of the Commissioners to public libraries and museums, literary and scientific bodies and official authorities, in the United Kingdom and abroad:
- (*g.*) The making printing publishing and selling of indexes to and abridgments of specifications and other documents in the Patent-office:
- (*h.*) The admission of the public to the museum and library provided under this Act:
- (*i.*) The remuneration (subject to the approval of the Treasury) of assessors:
- (*k.*) And generally for prescribing and regulating the management of the Patent-office museum and library, and all things by this Act placed under the direction or control of the Commissioners.

52.—(1.) All general rules made under this Act by the Commissioners shall as soon as may be after they are made be laid before both Houses of Parliament if Parliament be sitting; and if Parliament be not sitting then within *fourteen* days of the commencement of the next Session.

(2.) If within *six weeks* of any rule being laid before Parliament either House resolve that the same ought to be disallowed, that rule shall be invalid and of no effect, without prejudice nevertheless to any operation of the rule before disallowance.

(3.) A rule though made before, does not in any case take effect till after, the commencement of this Act.

53. Copies or extracts of or from the Register of Patents and the Register of Proprietors, and of or from specifications amendments and other documents in the Patent-office, shall, if certified on behalf of and sealed with the seal of the Commissioners, be admitted in evidence in all Courts in her Majesty's dominions, and in all proceedings without further proof and without production of the originals.

54. The Commissioners shall cause a report respecting the execution by or under them of this Act to be laid annually before both Houses of Parliament, together with an account of all fees salaries and other moneys received and paid under this Act.

55.—(1.) Not less than two Commissioners shall sit on the hearing of any opposition to the grant or prolongation of a patent, or of any petition for revocation of a patent or of any question as to the remuneration to be paid by the Crown for use of an invention or as to the grant of licenses:

(2.) Not less than two Commissioners shall concur in the making of any general rule, and in the appointment or removal of any examiner clerk or officer:

(3.) Subject as aforesaid and to any general rule of the Commissioners, any powers of the Commissioners under this part of this Act may be exercised by any one or more of them:

(4.) Any Act of the Commissioners shall not be invalid by reason only of any vacancy in their body or of the power to appoint any Commissioner not having been exercised.

56.—(1.) During a vacancy in the office or during the illness or absence of any Commissioner, or whenever for any other reason the Commissioners deem expedient, an Examiner may be appointed by writing under the hands of two Commissioners to act as and exercise all the powers of a Commissioner under this part of this Act.

(2.) Any such appointment shall be for a term not exceeding *six* months, but may be renewed.

Part II.

Infringement of Patents.

57. An action or other proceeding for infringement of a patent shall not after the commencement of this Act be commenced in any of Her Majesty's Courts of Justice in England.

58. For the purposes of this Act a person is deemed to infringe a patent if he copies altogether or in part the invention of a patentee with the view of effecting the same or a like object, and fails to establish any of the pleas allowed by this Act in a proceeding for infringement.

59.—(1.) A patentee may complain of any infringement of his patent to the Commissioners.

(2.) The complaint shall be heard and determined by the Commissioner (other than the legal Commissioner) who is best acquainted with the subject-matter of the complaint, assisted by a legal assessor to be appointed for the purpose by the Commissioners.

(3.) An appeal shall lie from the decision of the tribunal thus constituted to the three Commissioners, who shall hear the complaint *de novo*, and their decision shall be final.

(4.) The Commissioner or Commissioners sitting to hear any complaint may decide all questions of law and fact; they may by themselves or by any person appointed by them enter and inspect any place or thing being the property or under the control of any party to a proceeding before them; they may require the attendance of any person as a witness and the production of books and papers relating to the matter before them; generally they may (subject to the provisions of this Act) exercise all such jurisdiction and powers and make such orders as might have been exercised and made in a like case by any division or judge of the High Court of Justice in England.

60. The pleas allowed by this Act in a proceeding under this Act for infringement of a patent are—

That the particular matters alleged to be infringed, do not show sufficient invention to justify the grant of a patent, or are not new within the meaning of this Act;

That the patentee is not the true inventor of the invention or of so much of it as is alleged to be infringed;

That the matters complained of do not amount to infringement;

That the claim of the patentee as respects the matters complained of is not stated with sufficient clearness;

That the specification is, as respects the matters complained of, incomplete or misleading.

That the patentee as respects any matter complained of withheld that which he knew to be a better description than that given in the specification.

61.—(1.) In a proceeding for infringement of a patent the complainant must deliver the prescribed particulars of the infringement complained of:

(2.) The defendant must deliver the prescribed particulars of objections on which he relies in support of his pleas or plea:

(3.) In every case the particulars delivered shall comprise a statement of the places and manner at and in which the complainant or defendant alleges the infringement to have been committed, or the acts and things on which he founds the objections to have been done or to have happened, or the invention to have been, before the date of the patent published or used.

(4.) At the hearing no evidence shall, except by leave of the Commissioners, be admitted in proof of any alleged infringement or objection of which particulars are not so delivered:

(5.) Particulars delivered may be from time to time amended, by leave of the Commissioners.

(6.) On taxation of costs regard shall be had to the particulars delivered by the complainant and by the defendant; and they respectively shall not be allowed any costs in respect of any particular delivered by them unless the same is certified by the Commissioners to have been proven or to have been reasonable and proper, without regard to the general costs of the case.

62. In any proceeding for infringement of a patent the Commissioners may, and on the application of either party shall, obtain the assistance of an expert as assessor; and the provisions of Part I. of this Act relative to experts as assessors (including the provision as to remuneration) shall apply as if they were repeated in this section.

63.—(1.) The Commissioners may at any time after the passing of this Act and from time to time make vary and rescind rules of procedure prescribing and regulating—

(*a.*) The form nature and service of complaints particulars notices and other documents;

(*b.*) The period within which anything is to be done in a proceeding for infringement;

(*c.*) The nature and amount of security for costs to be given by complainants and others;

(*d.*) Generally the sittings of the Commissioners and the procedure on all matters brought before them under this part of this Act.

(2.) Every rule made under this part of this Act by the Commissioners shall as soon as may be after it is made be laid before both Houses of Parliament if Parliament be sitting; and if Parliament be not sitting then within *fourteen* days of the commencement of the next Session:

(3.) If within *six* weeks of any rule being laid before Parliament either House resolve that the same ought to be disallowed, that rule shall be invalid and of no effect, without prejudice nevertheless to any operation of the rule before disallowance:

(4.) A rule though made before, does not in any case take effect till after the commencement of this Act.

64.—(1.) Every person required by the Commissioners to attend as a witness shall be allowed such expenses as would be allowed to a witness attending on subpœna in the High Court of Justice in England.

(2.) In case of dispute as to the amount to be allowed, the same shall be referred to a master of the High Court of Justice, who, on request under the hands of the Commissioners, shall ascertain and certify the proper amount of such expenses.

65.—(1.) Any decision and any order made by the Commissioners under this part of this Act may be made a rule or order of the High Court of Justice, and shall be enforced in like manner as any rule or order of such Court.

(2.) For the purpose of carrying into effect this section general rules and orders may be made by the same authority and in the same manner as general rules and orders may be made with respect to any other proceedings in such Court.

66.—(1.) Where a patent bears on it a statement of the report of an Examiner in accordance with the provisions in that behalf of Part I. of this Act, then in the event of a patentee instituting any proceeding for infringement of the patent he

shall give security for costs of such amount (not being less than *one hundred* pounds) as the Commissioners think fit to order; and if he fails in the proceeding on any ground indicated in the said report he shall pay the costs of the defendant as between solicitor and client.

(2.) Subject as aforesaid the costs of and incidental to any proceedings before the Commissioners under this part of this Act shall be in the discretion of the Commissioners.

67. The costs charges and expenses of and incidental to any proceedings before the Commissioners which are incurred by any person shall if required be taxed in the same manner and by the same persons as if such proceedings were proceedings in the High Court of Justice.

68. This part of this Act does not extend to Scotland Ireland the Channel Islands or the Isle of Man.

Part III.

General Provisions.

69. Every document purporting to be signed by the Commissioners or any of them shall be received in evidence without proof of such signature and until the contrary is proved shall be deemed to have been signed and to have been duly executed or issued by the Commissioners.

70. The Public Offices Fees Act, 1866, shall apply to all fees taken in relation to any proceedings before the Commissioners.

Any fee or payment in the nature or lieu of a fee paid in respect of any proceedings before the Commissioners and collected otherwise than by means of stamps shall be paid into the receipt of her Majesty's Exchequer in such manner as the Treasury from time to time direct, and carried to the Consolidated Fund.

71.—(1.) Any notice required or authorised to be given under this Act may be in writing or in print or partly in writing and partly in print, and may be sent by post:

(2.) If sent by post a notice shall be deemed to have been received at the time when the letter containing the same would have been delivered in the ordinary course of the post:

(3). In proving such sending it shall be sufficient to prove that the letter containing the notice was prepaid and properly addressed and put into a post-office.

Part IV.

(i.)—*Transitory Provisions.*

72.—(1.) Every patent granted before the commencement of this Act, shall have such duration only as it would have had if this Act had not been passed; but as regards the third and the seventh year (if unexpired at the time of the commencement of this Act) of its term it shall, notwithstanding anything in any such patent contained be subject to stamp duties of *Thirty* pounds and *Sixty* pounds respectively and to no others; and the provisions of this Act respecting a certificate of renewal and respecting accident mistake or inadvertence in relation thereto shall also extend to every such patent:

(2.) The provisions of this act relating to the Crown and to the power of the Commissioners to order a patentee to grant licenses shall not extend to patents granted before the commencement of this Act:

(3.) Any action or other proceeding in respect of a patent pending at the commencement of this Act shall be tried and continued in like manner as if this Act had not been passed:

(4.) The term of a patent granted before the commencement of this Act may be prolonged for any period not exceeding *fourteen* years, as the Commissioners may see fit:

(5.) In all other respects this Act shall extend to all patents granted before the commencement of this Act in substitution for such enactments as would have applied thereto if this Act had not been passed; and in particular such patents are hereby expressly excepted from the operation of the Statute of Monopolies, and shall not be invalidated or affected by anything therein contained.

73. The Register of Patents and the Register of Proprietors kept under any enactment repealed by this Act shall respectively be deemed parts of the Register of Patents and the Register of Proprietors kept under this Act.

74. All applications for patents pending at the passing of this Act shall be heard and disposed of in the interval between the passing and the commencement of this Act, as if this Act had not been passed.

75.—(1.) All books documents and other property of every description vested in or under the management of the Commissioners of Patents for inventions existing at the commencement of this Act shall immediately on its commencement vest in and be under the management of the Commissioners constituted by this Act:

(2.) At the same time the staff of officers and servants of the existing Patent-office shall subject to any other arrangements made by the Treasury, be transferred to the Patent-office under this Act, at the like salaries and on the like tenure of their offices and places, and with as nearly as may be the like duties as formerly.

76. The repeal of enactments or any other thing in this Act contained shall not—

- (*a.*) affect the past operation of any of those enactments or the validity of any patent granted, or any compensation granted, or anything done or suffered under or by any of those enactments before or at the commencement of this Act; or
- (*b.*) interfere with the prosecution of any action or proceeding civil or criminal pending at the commencement of this Act in respect thereof; or
- (*c.*) take away or abridge any protection or benefit in relation to any such action or proceeding.

(iii.)—*Transfer of powers as to Registration of Trade Marks and Copyright of Designs.*

77. All powers duties and authorities vested in imposed on or exercisable by the existing Commissioners of Patents under the Acts relating to Registration of Trade Marks, and the Acts relating to Copyright of Designs, are hereby transferred to vested in and imposed on the Commissioners constituted by this Act; and those Acts shall be read and have effect accordingly.

(iii.)—*Scotland.*

78. A penalty under this Act in respect of the unauthorised use of a name word stamp mark or device may be recovered in Scotland by action or other proceeding or information in the Court of Session.

79. An order of the Commissioners for payment of costs may be recorded in the books of Council and Session in Scotland to the effect that execution may pass thereupon in common form.

(iv.)—*Ireland.*

80. Notwithstanding anything in this Act, all parties shall have in Ireland their remedies under or in respect of a patent as if it had been granted to extend to Ireland only.

(v.)—*Saving for Crown.*

81. Notwithstanding anything in this Act, it shall be lawful for her Majesty the Queen, her heirs or successors, by warrant under the Royal Sign Manual—

To direct any specification to be cancelled before the sealing of the patent, and thereupon the provisional protection shall cease:

To direct the Commissioners to refuse the sealing or issue of a patent:

To direct the insertion in any patent of any restrictions, conditions, or provisoes.

82. Nothing in this Act shall take away, abridge, or prejudicially affect the prerogative of the Crown in relation to the granting of any letters patent, or to the withholding of a grant thereof.

THE FIRST SCHEDULE.

PART I.

Acts partly repealed.

Session and Chapter.	Title or Short Title.	Extent of Repeal.
21 James I. c. 3. [Statute of Monopolies]	An Act concerning Monopolies and Dispensations of Penal Laws and the Forfeiture thereof.	Section six.
7 & 8 Vict. c. 69.	An Act for Amending an Act passed in the fourth year of the reign of his late Majesty, intituled an Act for the better Administration of Justice in his Majesty's Privy Council, and to extend its jurisdiction and powers.	Sections two to five, both inclusive.
28 & 29 Vict. c. 3.	The Industrial Exhibition Act, 1865.	Section three.
33 & 34 Vict. c. 27.	The Protection of Inventions Act, 1870.	Section two.

PART II.

Acts wholly repealed.

Session and Chapter.	Title or Short Title.
5 & 6 Will. IV. c. 83.	An Act to amend the Law touching Letters Patent for Inventions.
2 & 3 Vict. c. 67.	An Act to Amend an Act of the fifth and sixth years of the reign of King William the Fourth, intituled An Act to amend the Law touching Letters Patent for Inventions.
15 & 16 Vict. c. 8g.	The Patent Law Amendment Act, 1852.
16 & 17 Vict. c. 5.	An Act to substitute Stamp Duties for Fees on passing Letters Patent for Inventions, and to provide for the purchase for the public use of certain Indexes of Specifications.
16 & 17 Vict. c. 115.	An Act to amend certain provisions of the Patent Law Amendment Act, 1852, in respect of the transmission of certified copies of Letters Patent and specifications to certain offiees in Edinburgh and Dublin, and otherwise to amend the said Act.
22 Vict. c. 13.	An Act to amend the Law concerning Patents for Inventions with respect to Inventions for Improvements in Instruments and Munitions of War.

THE SECOND SCHEDULE.

Form of Letters Patent.

VICTORIA, by the grace of God, of the United Kingdom of Great Britain and Ireland, Queen, Defender of the Faith: To all to whom these presents shall come greeting:

Whereas A. B. hath by his petition humbly represented unto us that he is in possession of an invention for
which invention is described in the specification annexed hereto, and the petitioner hath also represented to us that the said invention will be useful to the public, that he is the true inventor thereof, and that the same is not in use by any other person to the best of his knowledge and belief:

And whereas the petitioner hath humbly prayed that we would be graciously pleased to grant unto him (hereinafter together with his executors, administrators, and assigns, or any of them referred to as the said patentee) our Royal Letters Patent for the sole use and advantage of his said invention within our United

Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man.

And whereas we being willing to encourage all inventions which may be for the public good, are graciously pleased to condescend to the petitioner's request:

Know ye, therefore, that we, of our especial grace, certain knowledge, and mere motion do these presents, for us, our heirs and successors, give and grant unto the said patentee our especial licence and full power and sole privilege, that the said patentee by himself his agents or licensees and no others may at all times hereafter during the term of years herein mentioned make use exercise and vend his said invention within our United Kingdom of Great Britain and Ireland the Channel Islands and Isle of Man in such manner as to him may seem meet and that the said patentee shall have and enjoy the whole profit and advantage from time to time accruing by reason of the said invention during the term of yeers herein mentioned; To hold exercise and enjoy the said license powers and privileges unto the said patentee during the term of *seventeen* years from the day of : And to the end that the said patentee may have and enjoy the sole use and exercise and the full benefit of the said invention we do by these presents for us our heirs and successors strictly command all our subjects whatsoever within our United Kingdom of Great Britain and Ireland the Channel Islands and the Isle of Man that they do not at any time during the continuance of the said term of *seventeen* years either directly or indirectly make use or put in practice the said invention or any part of the same nor in any wise imitate the same nor make or cause to be made any addition thereto or substraction therefrom whereby to pretend themselves the inventors thereof without the consent licence or agreement of the said patentee in writing under his hand and seal on pain of incurring such penalties as may be justly inflicted on such offenders for their contempt of this our Royal command and of being answerable to the patentee according to law for his damages thereby occasioned: Provided that these our letters patent are liable to be revoked on the grounds and in the manner from time to time by law provided: Provided also that if the said patentee shall not pay all stamp duties by law required to be paid in respect of the grant of these letters patent or in respect of any matter relating thereto at the time or times and in manner for the time being by law provided and also if the said patentee shall not supply or cause to be supplied for our naval or military service all such articles of the said invention as may be required by the officers or Commissioners administering any department of those services respectively in such manner at such time and at and upon such reasonable prices and terms as shall be settled in manner for the time being by law provided that then and in any of the said cases these our letters patent and all privileges and advantages whatever hereby granted shall determine and become void notwithstanding anything hereinbefore contained: But nothing herein contained shall prevent the granting of licenses in such manner and for such considerations as they may by law be granted: And lastly, we do by these presents for us our heirs and successors grant unto the said patentee that these our Letters Patent shall be constructed in the most beneficial sense for the advantage of the said patentee. In witness whereof we have caused these our letters to be made patent this One Thousand Eight Hundred and in the year of our reign and to be sealed as of the said One Thousand Eight Hundred and

By Order

Specification.

To all to whom these presents shall come:
I, A. B., of send greeting:

* *Whereas* I the said A. B., on the day of 18 lodged in the Patent-office a provisional specification of the invention herein mentioned and applied for a grant of a patent for my said invention unto me the said A. B., my executors administrators and assigns. Now know ye that I the said A. B. do hereby declare the nature of my said invention and in what manner the same is to be performed to be particularly described in and by the following statement (that is to say,)

[*Describe the Invention.*]

In witness whereof I have hereunto set my hand and seal this day of A.D.

L.S.

* Note.—If no provisional specification was lodged the recital will run:—*Whereas* I the said A. B., on the day of 18 , applied for a grant of a patent for the invention herein described unto me, &c.

THE THIRD SCHEDULE.

Stamp Duties.

	£	s.	d.
On application	2	10	0
On grant of patent	10	0	0
On expiration of 4th year of patent	30	0	0
On expiration of 8th year of patent	60	0	0
On application to amend specification	2	10	0
On order giving leave to amend	2	10	0
Prolongation of patent—for each year of prolongation	10	0	0
On certificate of record of notice of appeal against decision of Examiner	1	1	0
On certificate of record of notice of opposition to any application	1	1	0

CANTOR LECTURES.

WATCHMAKING,

By Edward Rigg, M.A.

Lecture III.—Delivered Monday, Feb. 21, 1881.

Necessity of efforts to promote the art in this country —Need of education, theoretical and practical, in horology—Literature—Great want of uniformity in gauges, screws, &c.—Exhibition of ordinary and complicated watches, and of watchmakers' tools—Conclusion.

The published syllabus of this third lecture makes me feel very strongly that some explanation and, as far as possible, justification of the subject-matter therein mentioned is due to my audience, more especially when the technical character of the last lecture is borne in mind. But, remembering the object with which this Society was originally formed, and which it has for a century and a quarter steadily kept in view, the promotion of arts, manufactures, and commerce, I feel I have some grounds for hoping that those who have seriously thought of the condition of the horological art in this country will admit that I could not fairly have taken a very different course. Watchmaking is an art in a very high sense of the term, and, in addition to being of universal interest, it is well deserving of scientific investigation, if only from the fact that it brings the worker into closer relation with many abstruse physical forces than

perhaps any other branch of mechanics; and it is not extravagant to hope that it will in the future help us to a fuller knowledge of them. And yet the amount of attention it has received from men of science has been very small, especially in this country. Most of its truths have been arrived at, not by scientific reasoning, but by pure experiment and observation, and most of the treatises on horology consist rather of statements of facts and descriptions of apparatus than of any logical train of argument. One consequence of this is that the great majority of those engaged in the art regard science as in no way a concern of theirs, and, as Saunier has pointed out, are not unfrequently ready to take offence at any suggestion that they could benefit by a knowledge of it. As an instance of this, take the case of the best form of teeth of wheels. No mechanician doubts the advantages of epicycloidal or involute teeth, but how often is a watchmaker found to believe in them as bearing on his trade? He knows that if his cutter is of a form which experience has shown to be satisfactory, a very good depth may be secured, but he ignores the fact that this vaunted experience has only led, more or less accurately, to the discovery of one or other of those forms that were proved by mathematical investigation to be the best more than a century ago.

While the industry would have materially benefited in the past by the aid that science had to offer, a specially adapted scientific training is more than ever necessary to its well-being in the future. In face of the eager competition by which it is assailed at the present day, we may be certain that it cannot remain stationary, and if there is not good evidence to show that advance is made, we may safely conclude that it is in a decaying state.

But not only is all knowledge of science omitted from the training of the watchmaker; now-a-days, even the manual skill is in great part wanting, and it is a general complaint that no sufficient supply of competent young workmen is to be found to take the place of the older men; indeed, I am assured that practically the whole of the best work in Clerkenwell is now performed by men advanced in years. This has resulted from the failure of the old system of apprenticeship and the neglect to provide a substitute, a change in our social condition which has more than once been discussed in this room.

One of two results must necessarily follow from this state of things, and that very shortly: energetic steps must be taken to provide for the education, both theoretical and practical, of our rising young workmen, or the quality of the best English work must rapidly deteriorate. And this urgent need of technical education has now forced itself upon the attention of every watchmaking community, those on the Continent, already in possession of schools, doing all in their power to enhance their utility and increase their number, while America, notwithstanding the minute elaboration of its machinery, is fully alive to their necessity.

Switzerland already possesses six such schools, Germany two, and France three, that of Paris having only been opened on the 6th of March in the present year. As showing how its importance is constantly borne in mind by the watchmakers of that city, I would mention that for seven years a subscription list has been open for the purpose of establishing a school of watchmaking, and their private exertions have at length secured a sum sufficient both for the establishing and maintenance of such a school.

In England, however, the special instruction hitherto available for watchmakers has been very slight, consisting mainly of drawing classes and occasional lectures on technical subjects at the Horological Institute. But in the early part of last year very important additions were made to the instruction there given, through the liberality of the City and Guilds of London Institute for the Promotion of Technical Education; and, thanks to them, we now possess a horological school whose immediate future must have a marked influence on the progress of English watchmaking, and will be looked to with no little interest by all who desire the art to prosper in this country. Indeed, I think it has a wider interest. Technical instruction has for many years had its eager advocates, among whom I may be permitted to mention my late father as having been the first to organise, 35 years ago, classes for the teaching of various trades, such as carpentry, mechanical engineering, printing, bookbinding, glass staining, &c., at Chester; but never was public attention so thoroughly directed to its necessity as it is at the present day. This school of horology is one of the first founded by the City Guilds Institute, and I doubt whether they could have selected a trade more suitable for the purpose of demonstrating the practicability of technical education among us. For the experiment can be made efficiently without the purchase of a very elaborate plant, theoretical and practical instruction can easily be carried on side by side, and the student can be placed in conditions similar to those in which he will find himself in after life. A further recommendation consists in the fact, that the scheme admits of a gradual extension, so as ultimately to include all the allied branches of the trade, such as dial and case-making and engraving, as well as to clock and chronometer making, and to that most important but sadly neglected branch, tool making. At the same time a rapid advance must not be looked for, for the art is of such a character as to require a special preliminary training of the pupils, so that the more or less complete want of this instruction will render their progress proportionately slow.

The school has existed since the summer of last year. In addition to the various branches of the art to which the pupils devote four full days a week, there are classes and lectures for instruction in the elementary principles of physics and mechanics that have a bearing on horology. It is gratifying to observe that all the benches at present available for practical pupils are occupied, and the progress they have hitherto made justifies a hope that the experiment will prove to be in every way successful. Systematic instruction has been one of the urgent wants of the watchmakers of this country for at least half a century; with the powerful support of the City Guilds they now have an opportunity, such as many of the continental centres of the industry may well envy, and it is for them to see that the most active encouragement is given to the experiment. In the

face of a steady depression in trade, the English watchmakers have, with most praiseworthy efforts, erected a Horological Institute; it remains for them to continue their exertions, in order to ensure success in the application of that Institute to its legitimate uses.

On one point I would venture to make a special appeal. The practical classes are necessarily limited in number by the space available, and although it is earnestly to be hoped that means may, ere long, be found to increase the accommodation, they must always be, in a sense, inelastic. But this is not the case with the lectures or theoretical classes, and if those actually engaged in the trade could, as a body, be brought to perceive that a scientific knowledge of their art is often even more essential than manual skill as a means of securing real progress, all the more so because the art is already in a highly advanced state, the theoretical instruction provided would not be confined, as it now is, entirely to the practical students. The Technological Examinations of the City Guilds Institute—examinations which have for many years been carried on, in various trades, with such signal success by this Society—may be expected to form an additional inducement to the younger members of the trade to join these or other similar classes, even although it involves the devotion of a few of their working hours to study. The prizes, medals, and certificates will constitute guarantees of a certain amount of theoretical knowledge such as have never existed in this country before, and it is not too much to expect that the higher standard of education to be secured by these means will immensely facilitate the introduction of some of the other improvements to which reference has already been made.

As the reduction in the number of men competent to undertake high-class work may be traced to the gradual failure of the old apprenticeship system, so the general lowness in the standard of theoretical knowledge is undoubtedly in great part due to the want of a special literature. It is simply incredible that English horology should have attained the eminence it certainly has attained without possessing a single treatise that could pretend to be even approximately complete. A partial exception should, perhaps, be made on behalf of Thomas Reid's volume, "On Clock and Watchmaking," published in 1826, but he directed his attention mainly to clockmaking. There are, of course, trade journals, &c., but the watch and chronometer may be said to have been ignored except in such volumes as those of Harrison, Mudge, Earnshaw, and others who had special inventions of their own to describe. And this may, perhaps, help to account for the neglect of the subject by the public, notwithstanding a few small treatises written for their edification. As I incidentally observed in the first lecture, France is exceptionally well supplied in this respect, as witness the elaborate works of Thiout, Berthoud, Lepaute, Dubois, Moinet, the more recent "Traité d'Horlogerie Moderne" of M. Saunier, and the many profound investigations into the theory and use of the marine chronometer, which were lately published, in a collected form, by M. Ledieu, in a work on the "New Methods of Navigation." M. Saunier's work, thoroughly practical, and, at the same time, constituting a scientific discussion of the principles involved in watchmaking, such as had not previously been attempted, is the recognised text-book in use in all the horological schools of the Continent, and I am sanguine enough to trust that the translation of it, which Mr. Tripplin and myself have recently completed, will be of service to the art in this country, both as an instrument of education and a work of reference, and as a means of reviving public interest in the subject. Several works of the utmost value to the art have come from the pen of M. Saunier, notably the *Revue Chronométrique*, now in its twenty-ninth year of publication; and we hope, before the end of the present year, to complete the translation of another smaller volume by the same author, "The Watchmakers' Handbook," which is of a more purely practical character, and calculated to afford invaluable assistance in the daily work of watchmaking and repairing.

A brief reference was made at the end of the last lecture to the question of standard sizes. Whatever steps are taken with a view to establishing the English trade on a firmer footing, it is unquestionable that the systems of measurement must come in for an important share of consideration. Various efforts at reform have been made during the last half century, but with no material result, and the late Charles Frodsham, in an unpretending but remarkably useful little pamphlet of 40 pages, entitled, "A Few Facts Connected with the Elements of Clock and Watchmaking," published in 1862, threw out a number of important suggestions on the point, which, I believe, have hitherto received but little attention. The complexity of the present system, if system it can be called, is well illustrated by his account of the Lancashire movement gauge. He experienced considerable difficulty in discovering the scale by which the well-known numbers used to designate sizes are related, and concludes that they represent successive additions of thirtieths of an inch to an initial inch, which is called 0, with a constant addition of $\frac{5}{30}$ths inch for the "fall," or room to allow the works to open and shut in the case. Thus a 16-size watch will have a diameter of $1 + \frac{16}{30} + \frac{5}{30}$ or 1·7 inches, which obviously is quite unconnected with the gauge number, unless the above law happens to be known; and, I would add, even this amount is not a constant, for different manufacturers employ slightly different gauges, and thus it happens that almost every movement requires a case and dial to be specially made for it. The graduation of the pillar gauge, by which the distance between the two plates of the watch is measured, is even more complex. $\frac{1}{12}$th inch is expressed by the utterly meaningless combination $\frac{0}{6}$; $\frac{1}{8}$th inch is called 0, and $\frac{30}{0}$ is equal to $\frac{3}{12}$ths inch.

In place of all this gratuitous confusion, he proposed a system of measurement by decimals of an inch for all parts of the movement, and it is much to be desired that some such modification should be introduced when the reforms in the watch trade which are so urgently needed are effected. It would be travelling beyond my present purpose to enter into this question of gauges, but the subject well deserves discussion, and it would be impossible to take full advantage of any system unless it received the cordial support of the entire trade.

[A very complete collection of the gauges used

by watchmakers, most of which had been lent by Messrs. Grimshaw and Baxter, was exhibited, and the want of uniformity in their systems of graduation pointed out. Sets of standard gauges that commenced at $\frac{1}{100}$th inch and differed by $\frac{1}{1000}$th inch were also kindly lent by Sir Joseph Whitworth.]

Many of the gauges in ordinary use, such as the wheel-gauge, and the main-spring gauge, are graduated on an easily intelligible system, and, as they are of foreign manufacture, their basis is in nearly all cases the millimètre. They are cheap, sufficiently accurate for the purposes for which they are intended, and as a large number of materials used by the generality of watchmakers are also of continental origin, it seems all but impossible that the inch can be established as a sole unit in the trade, but a double graduation on certain gauges is all that would be required to enable watchmakers to work on either system, as circumstances might render necessary.

The Society of Arts of Geneva has recently investigated this question of gauges as well as that other closely allied subject, the threads of screws, and they have proposed certain standards which the Swiss manufacturers seem disposed to adopt. It is to be hoped that English makers may see their way to introduce the same standards, at any rate in so far as they are brought in contact with the continental trade.

The Whitworth standards afford an invaluable basis for watchmaking, and when the manufacturers and movement makers have come to an understanding to work rigidly to them, a very important step will have been taken towards the systematising of the English trade. There are many departments of the manufacture that are, so to speak, self-contained, and do not directly come into contact with the gauges in use on the Continent, and for them the value of these standards cannot be over-estimated. As bearing on this question, I must not omit to mention that the Standards Department of the Board of Trade has recently made arrangements by which great facilities are offered for verifying gauges of all kinds on this system, having procured a complete series of standards comprising all dimensions from $\frac{1}{100}$th inch to six inches. This should constitute an additional reason for watchmakers taking steps to reorganise their systems of measurement.

There is but one other point to which I desire to make a brief reference before proceeding to exhibit, by the aid of the electric lamp, a number of watches of various degrees of complexity, which the kindness of friends has enabled me to collect here this evening.

The varied collection of tools, for the loan of most of which I am indebted, as was the case with the gauges, to Messrs. Grimshaw and Baxter, was intended, primarily, to show the types of tool that an ordinary watchmaker or manufacturer on the hand system employs. It will be seen at once that they differ entirely in design from the machines employed by other workers in metal, and often the mechanical devices used are radically different. Such a collection as this is, of course, not likely to present much novelty to watchmakers, but it is well worthy of examination by all who are interested in mechanical work, as many of the tools present special features that might with advantage be adopted in larger machines. [As examples, mention was made of the pump centre of a mandril, by which almost any piece can be centred with the utmost facility, and the depth tool used in the clock, chronometer, and watch trades for determining the positions of pivot holes, so that wheels and pinions should run smoothly together. A number of the tools were briefly explained, and their special features as compared with those used in other mechanical arts were pointed out. The attention of watchmakers was also drawn to the beautiful series of tools manufactured by M. G. Boley, of Esslingen, Wurtemburg, some of which were exhibited.]

And I had another object in bringing these tools here this evening. I want to draw attention to the very great interest that watchmaking possesses for those that amuse themselves with mechanical pursuits; and, without in any way wishing to decry that most perfect tool, the lathe of, say, four or five inch centre, the usefulness of which, indeed, it would be difficult to over-estimate, I feel very strongly that its smaller relatives have hitherto been too much neglected by amateurs. The tools employed in watchmaking can be obtained at comparatively moderate cost, and lend themselves to great variety of operations on a small scale. They occupy but little room, and, although of course I am far from pretending that amateur mechanics could actually make a watch, I can positively say from experience that, if they would interest themselves more in the subject, they would derive a great amount of pleasure, even from the mere cleaning of a common watch, and the higher branches of the art are naturally more attractive. In England it has hitherto been kept far too much to itself, and the sympathy with its advance which the interest of amateurs would develope could hardly fail to benefit the trade generally. On the Continent its advantage was long ago recognised; thus in 1860, an eloquent article appeared in the *Revue Chronométrique*, from the pen of M. Philippe, of Geneva, "On the necessity for some remedy to arrest the decline of Horology," in which reference was made to this question. He says:—

"If the attention of the public was more frequently directed to our work, if they were more initiated into the difficulties of the art and its scientific aspects, we might succeed in creating a band of amateurs such as formerly existed, such as still exists in all the arts and very many of the sciences . . . . to the advantage of those high-class workers, whose energy and whose talents would often be discouraged without such support."

In the preceding lecture I have referred to the urgent necessity of reform in the tools used in watchmaking; while this primarily had reference to the more extended use of machine tools, it is in a less degree applicable to the smaller instruments used by the maker or repairer. England formerly manufactured her own, but now most of the tools in use are of Swiss construction. And yet Prescot still possesses makers unsurpassed in manual skill by any in Switzerland, and would, doubtless, possess many more, were it not for the fact that the trade was long ago crippled by the underselling of their competitors. They seem to suffer from the same failing as is only too noticeable in other branches of the trade, want of "life," which

is apparently nourished by an unfounded feeling that watchmaking cannot aspire to be a national industry.

This inactivity is, after all, more responsible for the present depression than any deficiency of tools, and, in evidence of this, I would quote the case of Besançon. There, the system of manufacture is essentially the same as ours. The tools employed are similar, machinery being only applied, as at Prescot, to the movement-making. But, while our trade is contracting, theirs is expanding at a remarkable rate. Thus, in the five years 1845-9, the official returns show that the Besançon district completed 239,323 watches, of which 16 per cent. were gold. The out-turn has been steadily increasing since that period, and in one year, 1878, no less than 454,886 were manufactured, nearly double the number given for the above period of five years, and the per-centage of gold cases rose to 32.

Yet, in face of this expansion, which has continued through a period of universal depression in trade, the Besançon manufacturers are keenly alive to the necessity of extending the use of machine-tools. Their success is mainly due to the possession of that essential quality—energy; and they are further supported by the conviction that watchmaking *is* a national industry. I am far from denying that, in this country, there are many keenly alive to the necessity of radical changes; but individual exertion is not sufficient, and no collective action has yet been taken by the manufacturers.

[The lecturer then proceeded to exhibit a number of watches, projecting them on to the screen by the aid of the electric lamp. The collection comprised many varieties of keyless watch, quarter, half-quarter, and minute repeaters, stop-watches, minute and split-seconds chronographs, pedometer and calendar watches, mechanical and musical watches, antique watches, blind man's watch, &c. He expressed his indebtedness to the undermentioned gentlemen and firms, who had kindly lent them for exhibition—Dr. Longton, Southport, for a collection of 24 watches; Messrs. Lund and Blockley; Messrs. Patek, Philippe and Co.; Messrs. Guye; Mr. Glasgow; Herr Von Lohr; Mr. Tripplin.]

And here I must bring this course of lectures to a conclusion. It remains, however, for me to thank most sincerely those many friends whose liberal assistance has enabled me to exhibit these valuable watches, as well as the tools, gauges, and parts of watches at this and the preceding lectures. It is no small privilege to be entrusted with such a collection as that lent me by Dr. Longton, of Southport, and I am sure that his kindness as well as that of others, whose names I have mentioned, will be as much appreciated by you as it is by me. The assistance I have received from various members of the trade has been very great, and if I have been so fortunate as to interest any of my audience in the progress of the art in this country, it has been in great part owing to the specimens and information with which they have always most readily supplied me. And I must not omit to acknowledge the valuable aid I have received from Mr. S. G. Willmott, who has prepared these beautiful diagrams.

Looking back at the ground over which we have gone, I cannot help feeling how many points have been either ignored, or barely referred to, that are nevertheless of the highest importance. But I felt that questions of a theoretical or merely descriptive nature, if discussed with sufficient fulness, would extend over far more than three lectures, and that such points as those to which I have drawn attention are so much in need of consideration, that I might count on your indulgence in treating of watchmaking in a manner somewhat different from what is generally expected in a Cantor course. It is very seldom that the art is brought before the public at all; and I therefore feel the more honoured in being allowed to urge its claims to attention in the room of this Society.

There are many reasons why reforms introduced into the system of manufacture would now stand a better chance of being successful. We may confidently look forward to the technical instruction of our young watchmakers improving. Foreign competition is forcing itself more and more on our notice, and the literature of the art has received important additions. If, then, some of our most prominent horologists at the several centres of the industry, would jointly consider the many questions that need solution—the calliper, the gauges, and the system of manufacture—and if the several branches of the trade would cordially work together for the general good, we might look with confidence for a marked improvement in the official returns in the near future. The cheaper class of English watch would gradually shake off the discredit that seems too often to hang over it, and might compete with some chance of success with those of foreign construction, at any rate, in our own country.

MISCELLANEOUS.

EDUCATION REPORT, 1880.

The report of the Committee of Council on Education just issued, has formed the text of a leader in the *Times*, from which it appears that the following are some of the chief results. While the schools inspected in 1870 were only 8,281 in number, in 1880, after but ten years had elapsed, they numbered 17,743. In the former year accommodation was provided for less than two millions of children; now there is accommodation for four millions and a quarter. The average attendance in 1870 was 1,152,389; last year it was 2,750,916—an increase of a hundred and fifty per cent. This increase is not to be set down solely to the Board schools, for the voluntary schools have at least kept pace with them. While in the year of the Act there were but 8,281 voluntary schools inspected, these had increased to 14,181 in 1880, the total number of the Board school being now only 3,433, and the numbers of children in attendance in the voluntary schools bearing to those in the Board schools a proportion of about five to two. The result of the last inspection showed an improvement not only in the numbers of children, but in the quality of the work done. In the case of "specific" subjects, in which the grant depends on the proficiency shown by individuals, and which are open to children who have reached the fourth standard, 160,333 offered themselves out of 476,761 presented in that standard, and of these over a hundred thousand passed, the favourite subjects being English, animal physiology, physical geography, and household management, or, domestic economy.

Taking the large schools with the small, and allow-

ing for the help given by pupil-teachers, about one certificated master or mistress for every hundred children is assumed to be a fair allowance, so that if 3,500,000 is to be taken as the full number who ought to be receiving elementary instruction in England and Wales, the teachers should number about 35,000. The actual number now existing is 31,422, who are mainly recruited by the training colleges, such as those at Battersea and Culham. Mr. Sharpe, the Inspector of the Colleges for Masters, says that the training colleges "do not supply the demand for the poorer classes of schools; they practically supply the demand for schools which can afford to pay about £100 a year for head or assistant teachers." Out of some 13,000 masters, there are 1,000 who are earning more than £200 a year, with houses; out of 8,000 mistresses there are nearly 300 earning the same. More important is the general result, which is thus stated in the report:—"The average salary of a certificated master, which in 1870 was £95 12s. 9d., is now £127 2s. 7d.; that of a schoolmistress was £57 16s. 5d. in 1870, and is now £72 12s. 8d." About a third of the whole number are provided with residences rent free. Whereas out of 431 Boards established in boroughs, only 21 have been compulsory, to meet a deficiency in school accommodation, in the case of unincorporated towns and rural districts no fewer than 1,000 out of 1,920 Boards have been established by order of the Department. The area under "compulsory attendance bye-laws" has been steadily increasing, so that while, in 1872, a population of eight millions was all that was included, the population subject to these laws is now, including that under School Attendance Committees as well as that under Boards, more than twenty-two millions. In the voluntary school a child costs in London about £2 a year to educate; elsewhere, from 30s. to 36s. In the Board school he costs in London about 57s.; elsewhere, from 28s. (in Hull) to 47s. (in Bradford). He earns from 15s. to 17s. from the Government grant. He pays from 8s. to 15s. in school pence; in the voluntary schools the subscriptions, which eke out the expenses, amount to an average of 6s. a head, and in the Board schools the amount contributed by rates amount to sums which vary from 3s. 2d. in Hull to 33s. 7d. per child in London, the average being about 15s. Taking the whole amount spent on elementary education, it appears that the sum contributed by voluntary subscribers is almost exactly equal to that levied by rate—£739,155 as compared with £726,226; and that both added together amounts to almost exactly the total coutributed by fees—viz., £1,431,828. The total Government grant amounted last year to £2,130,009.

NOTES ON AMERICAN SCIENCE AND MECHANISM.

A New Theory Concerning Boiler Explosions.

A public-spirited individual, Mr. D. T. Lawson, of Pittsburg, Pennsylvania, has just succeeded in affording data for the solution of a problem that, up to the present time, is believed to have baffled engineers, viz., the cause of the bursting of steam-boilers under certain circumstances. Repeated attempts had been made under both Government and private auspices to burst a boiler intentionally with the terrific force known in such connection to spread havoc far and wide, but all such attempts had failed, the collapse of a flue having been the most that was attained. But an explosion has at length been obtained on a scale so grand as to blow the boiler into fragments, which were scattered all over the farm on which the experiment was made. This boiler was built of the very best materials expressly for this trial, and was constructed in the best possible manner. At one o'clock the fire was started, and at five o'clock everything was ripe for the experiment. The boiler, which was six feet in length by thirty inches in diameter, was all that time three-fourths full of water, which was seven or eight inches above the fire-line, and the steam-gauge showed a pressure of 380 pounds to the square inch, the tensile strength of the boiler being 604 pounds to the inch. The spectators having retreated to the bomb-proof sheds erected by the Government, by the agency of a string the valve was pulled, and a full head of steam let into the cylinder. This was attended by an explosion so terrific that the earth shook as if by an earthquake, and when, a few seconds afterwards, the shower of *debris* had somewhat passed, and an examination made, everything was found to have been completely demolished and torn into fragments, some of which were found over half-a-mile away from the scene, others being projected to a greater distance.

The theory that was sought, and is believed by Mr. Lawson to have been established by the experiment narrated, is as follows:—"Superheated water" is the only explosive element in a steam boiler, and when highly superheated, it is as explosive as gunpowder, but it does not explode from the same cause nor in the same manner. Gunpowder explodes by chemical union, upon ignition, the explosion being accompanied by a visible flash. Superheated water explodes, on a sudden reduction of the pressure from its surface, by bursting into steam, which instantly fills over 1,700 times the space occupied by the water. An explosion, therefore, only takes place after the engineer has opened the port and allowed a small portion of the steam to escape into the cylinder, creating a vacuum to that extent over the superheated water, a portion of which instantly bursts into steam, striking every square inch of the boiler with a concussive force many times greater than the regular pressure of steam. The numerous explosions which takes place just as steam is turned into the cylinder at starting are claimed by Mr. Lawson to corroborate his theory.

By suddenly injecting cold water into a boiler of superheated water an explosion will, on the same principles, be caused. The fact of explosions occurring under such circumstances has long been recognised, but in the estimation of many they were supposed to be caused by the cold water coming into contact with the heated iron of the boiler—an hypothesis Mr. Lawson claims is no longer tenable, for viewed in the light of his experiment the cold water would, merely by condensing the steam in the boiler and withdrawing the pressure upon the superheated water, favour the expansion of the latter into steam possessing a greater degree of pressure than any ordinary boiler could stand. Another experiment is soon to be made with a boiler tested under similar conditions, but which it is believed will not burst. In it the means of safety are found in constructing a partition to intervene between the flues and the top of the boiler, thus creating a steam compartment over the water compartment, to be supplied with steam evoked from the water through valves in the partition, and which valves are smaller in the aggregate than the part through which the cylinder is fed from the steam compartment.

The Glasgow readers of this *Journal* will probably recollect of an explosion that took place on board of a new and very quick passage steamer—the *Telegraph*, I think, although I have no means at present of verifying this—over thirty years ago. She stayed at a pier down the Clyde for a short period to land passengers, and no sooner was steam admitted to the cylinders to start her, than the boiler exploded with great violence. Numerous theories were hazarded by scientific men at the time to account for the explosion, that which was considered most tenable being the decomposition of the water or steam into its elementary gases by contact with the red-hot plates of the boiler) which also served to ignite the gases (oxy-hydrogen, thus formed. The new theory of Mr. Lawson as to explosions appears to me to meet this case, and explain it in a more satisfactory manner.

Determination of the Heating Power of the Sun, and of the Colour of its Light.

A party of scientific men have just started upon an expedition of a novel nature. The enterprise has for one of its objects the ascertaining whether the real colour of the sun be not blue, although its main object is to determine by actual experiment the amount of heat given by the sun to the earth. One of the most elevated summits on this Continent in an extremely arid region being essential, the expedition will proceed to the neighbourhood of Southern California or Arizona. It is well known that the chief of the expedition, Prof. S. P. Langley, Director of the Allegheny Observatory, who has acquired a reputation in connection with solar physics, firmly holds that the sun is neither white, yellow, nor red, but of a "deep, dark, beautiful blue," the colour being modified to its usual appearance by its passage through the atmosphere. The value of the inquiry is found in the fact, that if our atmosphere has played the part of an obstructor and modifier of the real colour of solar rays, an enormous proportion of the sun's heat has not been taken into account in those questions of scientific meteorology which have a special bearing on climate.

A Tornado of Unusual Violence.

At almost every hour during these two days are telegrams and letters pouring in, giving an account of one of the most fearful tornadoes which has ever visited the United States, and by which an entire city has been nearly swept out of existence. The force and fury of the storms in the "Far West" are well recognised as matters of frequent occurrence; but nothing, fortunately, for many years, has occurred at all to be compared with that which, three days ago, and in the course of a few minutes, almost obliterated the thriving little city of New Ulm, Minnesota. Many have been killed, a much greater number injured, a still greater number quite ruined, so far as concerns worldly goods. Pending the arrival of the reports from the scientific men and newspaper correspondents, who have started off to visit the scene of this tornado, the few following facts may be accepted as correct:—At twelve minutes to five o'clock in the afternoon of the 15th inst., a dark cloud, which had been seen approaching rapidly from the north-west, engulfed the city, which, at the same instant, was struck by a cyclone that in two minutes had levelled churches and many houses. Total darkness supervened, the noise of the tempest being appalling, especially added to the shrieks of women and the shouts of men, as houses were being thrown down, and their roofs sent flying through the air. After a minute or two a lull ensued, and people began to breathe more freely, when all of a sudden the fated city was struck with greater violence than before by the storm from a nearly opposite direction, and this completed the work of devastation. At two minutes to five the fury of the storm had subsided, but during the ten minutes that it lasted it was shown how active could be the forces of nature. One man describes how, when speaking to his wife, he found himself suddenly being carried through the air a distance of some hundred feet. The head of a well-known young lady, who is believed to have been struck by a piece of timber, was afterwards found on a prairie some distance away, and far from her body. The head of another lady was found at a distance of a tenth of a mile from her body. One child was carried over half a mile, and still lives. Many horses were killed, some having been lifted bodily through the air. Some framed houses have been carried away to such a distance, that no traces of them have yet been found. During the storm the lightnings were playing incessantly, and but for them the city would have been as dark as at midnight, for the fires, which continually were being kindled, could not spring into activity, on account of the torrents of rain. Some little time will have a elapse yet, ere the data are obtained on which to write, in a scientific manner, concerning this dreadful visitation. New Ulm is owned, and mainly occupied by Germans. The most terrible event in its history was its destruction during the Indian massacre, on the 19th of August, 1862. Since that time it has grown and prospered, the Indians having been effectually defeated. The scientific aspect of the storm will be interesting, as it is so seldom that one of so great violence occurs in the northern hemisphere.

J. T. T.

New York, July 18th, 1881.

GENERAL NOTES.

The Telephone in London.—The United Telephone Company state that they have now in London upwards of 1,000 subscribers, and that the "calls" average 6,000 a day. It is also announced that the company have arranged with the Post-office to connect three of their exchanges with the Postal Telegraph Department at St. Martin's-le-Grand, so that messages can be handed to non-subscribers having their place of business within a short radius of the Post-office, at a charge of 3d. per twenty words, or they will be forwarded anywhere in the United Kingdom at the usual rates for telegrams. The list of subscribers to the "Exchange" includes the Society of Arts.

Ceylon Pearls.—The Ceylon pearl fishery shows no sign of lanquishing, and a correspondent of the *Ceylon Observer* reports that a new bank has been fished, the oysters from which are of a larger size than those hitherto obtained at this fishery. The prices have run up from £3 to £4 14s., and if it is found practicable to extend the fishery for a time there is a great probability of the total amount received by the Government reaching £75,000, thus exceeding the fisheries of 1859 (£48,000) and 1863 (£51,017), though below the largest fishery on record, viz., that of 1814, which gave a return of £105,000. In spite of the high prices given the finds are reported to have been disappointing, the largest pearl being worth not more than £9. Up to date the Government share has netted £48,792.—*Journal of Applied Science.*

Patent-office Fees.—From a return just issued showing a classification of the whole receipts from the Patent-office for the year 1880-81, including stamps, under five heads, viz.:—Initial stages; third year fees; seventh year fees; other fees, certificates, sales, &c.; designs and trade marks, the following information is taken:—The amounts made on petitions for letters patent was £28,060; on applications with complete specifications, £1,105; notices to proceed, £20,230; warrants, £18,300; letters patent, £18,275; final specifications, £16,625; notices of objection to grant, £82; notices of objection to sealing, £20; on oppositions, £122; giving a total of £102,819. Third year fees came to £50,300; seventh year fees to £26,100; other fees, certificates, sales, &c., to £3,544; and designs and trade marks, £4,982 and £3,784 respectively, or in all £8,766. The total receipts have, therefore, been £191,529.

Electrical Meter.—The want of a meter which will measure the amount of electricity supplied to a private consumer is often urged as one of the difficulties to be overcome before a system of electric lighting can be widely introduced. It is now stated that Mr. Edison has devised a new meter for voltaic currents even more ingenious than the "Webermeter" which he proposed a year ago to fix in houses supplied with electric lamps. In the new instrument two copper plates are suspended in an electrolytic cell containing sulphate of copper in solution, and placed in a branch circuit through which a known fraction of the main current is shunted. The copper plates are hung upon a lever arm so adjusted that when by electrolysis one has grown a certain amount heavier (by deposition of copper) and the other grown an equal amount lighter, the lever tips up and reverses the current through the cell, and at the same time moves a registering dial-apparatus through one tooth. The action goes on again until the tilting lever is again overbalanced, and tipped back, when the current is again reversed, and another registration effected. Each "tip" clearly corresponds to the passing of an exact quantity of electricity through the cell, and the registered indications are, therefore, proportional to the total consumption. "But," says *Nature*, "will it work?"

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, is now open daily. A non-transferable season ticket will be sent to any member of the Society on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

PATENT LAW.

The following memorandum shows the principal alteration in the law which would be made by the Society of Arts' Bill for the Amendment of the Patent Law :—

Commissioners of Patents.—The Patent-office would be removed from under the charge of the present Commissioners, who are the Lord Chancellor, the Master of the Rolls, and the Law Officers. Three Commissioners would be appointed on account of their special knowledge.

Application for Letters Patent.—Method of Granting Same.—The method of application for a Patent would be somewhat as follows :—The applicant would file a Provisional Specification, which would be referred to Examiners appointed for the purpose. They would see that the invention was proper subject-matter for a Patent; that the Specification fairly described the invention, and that it was generally intelligible and properly drawn. They would not inquire into novelty or utility. They would report, and their report would be shown to the applicant before being seen by the Commissioners. The applicant would then have an opportunity of conferring with the Examiners as to any required alterations. Provisional Protection would be granted immediately on receipt of the application, and would last for nine months. Before the end of that time the applicant would be required to file a Complete Specification, fully describing his invention. This would be referred to the Examiners, and treated in the same manner as the Provisional Specification. The applicant would be enabled to amend his Specification in accordance with the recommendation of the Examiners, and on his doing so, a Patent would be granted. If the Examiners reported that the application was in respect of matters which could not properly be made the subject of a Patent, and if the applicant still persisted, a Patent would still be granted, but the objections of the Examiners would be endorsed upon the Specification.

Duration of Patent.—The duration of Letters Patent would be increased to 17 years—the duration being as now contingent upon the payment of fees at or before the expiration of each period.

Fees.—The fees would be half the present amounts, namely :—

Fee for Provisional Protection . . .	£2	10
Fee for Grant.	10	0
Fee at expiration of fourth year . .	30	0
Fee at expiration of eighth year . .	60	0

Existing System.—Under the present law there is practically no examination whatever. Applications for Patents are referred to one of the two Law Officers, who reports whether a warrant may be issued for the granting of Letters Patent. The only point upon which the Law Officer decides is whether the invention is proper subject-matter for a Patent, *i.e.*, whether it comes within the definition of the Statute of Monopolies (21 Jac. I., cap. 3) of being "a new manufacture within this Realm." The Complete Specification, upon which the Patent is really granted, is never examined at all by anybody.

Subject-matter.—The following is the definition of "subject-matter" adopted in the Bill :—

(*a.*) Any manufacture or any product not being a natural product;

(*b.*) Any machine or any means of producing any manufacture product or result;

(*c.*) Any process or method of producing any manufacture product or result;

(*d.*) Any part of a machine means process or method of producing any manufacture product or result.

At present the ancient definition of the Statute of Monopolies is in force, but, as a matter of fact, the question of subject-matter depends wholly on the decisions of the Courts.

Opposition.—Under the proposed Bill, opposition to the granting of Letters Patent would be limited to persons who could state that the applicant had obtained the invention from them by means of fraud. Under the present law any person can oppose, the general ground of opposition being that the person opposing already has a Patent for the same or nearly the same invention.

Amendment.—The Bill provides that the inventor should be entitled to amend his Specification after it had been first filed. Under the present system this power is very restricted.

Prolongation.—It is proposed to continue the system of prolonging Patents in special cases, the Bill being framed in such a manner as to give greater facility for this than now exists. Under the present system, prolongations are granted by the Privy Council, and are considered a matter of special favour, whereas the effect of the new Bill would, it is hoped, be to give them as a right to any inventor who could show just cause for having his privilege prolonged, on the ground of his not having had sufficient reward, or the time having been insufficient to enable him to bring his invention into action, or similar grounds. The period for which a patent could be prolonged

would be diminished by the three years which the Bill would add to its original term.

Obligatory Licenses.—The Bill would compel a Patentee to grant licenses in cases where it could be clearly shown that the invention was not being worked in such a way as to supply the reasonable wants of the public; but the clause has been so worded as to prevent any improper interference with the rights of the Patentee over what is considered to be his own private property.

Trial of Patent Cases.—The Bill would provide for the trial of Patent cases in an entirely new manner. They would be tried, in the first instance, before one of the Commissioners, and an appeal would lie to the whole body. The Commissioners would have power to call in Assessors, and would have such other powers as would enable them to try the cases fully. It is hoped that this would greatly simplify the Patent litigation, and would prevent the enormous expense which is now incurred by having to bring complicated questions of law and fact before a jury, who are probably ignorant of the scientific or mechanical considerations involved. It may be noted that one great source of expense is the preparation of models, which are only necessary to illustrate mechanical questions to persons unaccustomed to deal with such questions. For experts in such matters, drawings would be sufficient; indeed, an engineer would generally much prefer proper drawings to any model of a machine.

Anticipation.—It is proposed that a mere publication more than thirty years old, unaccompanied by use within the thirty years, should not be considered sufficient to invalidate a Patent. The object of this is to remove the hardship which now not infrequently occurs of a Patent being invalidated, or a Patentee being put to great expense in order to prove his claim, by the discovery of some ancient and probably incomplete description, a description which in many cases could not have been put into operation at the time it was made, for want of necessary appliances to carry it into effect.

Patents to Foreigners.—It is proposed that Patents should be granted to foreigners or persons resident abroad, on precisely the same terms as those on which they are granted to British subjects resident in the United Kingdom. At present Patents are granted to British subjects in respect of communications from abroad; that is to say, the theory is, a person travelling abroad sees a useful invention, brings it home, and patents it in England, such person not being, in any sense, the inventor. In practice, Patents for communications from abroad are nearly always taken out by Patent agents, whose clients are resident out of the country, and the Patent, as soon as it is taken out, is assigned to the real foreign inventor. Cases of injustice have occurred through the action of this system, in which a Patent has been granted to a person who had no moral right to it, but who anticipated the original inventor in obtaining the English Patent.

Effect of Foreign Patents on English Patents.—At present an English Patent lapses at the expiration of any foreign Patent taken out by the same inventor for the same invention. It is proposed in the Bill that English Patents should not in any way be affected by foreign Patents.

CANTOR LECTURES.

THE SCIENTIFIC PRINCIPLES INVOLVED IN ELECTRIC LIGHTING.

By Professor W. Grylls Adams, F.R.S.

Lecture I.—Delivered Monday, March 7, 1881.

The Production and Regulation of Electric Currents. —The Laws of the Mutual Induction of Currents and Magnets.

It has been well said, that rarely does a great discovery, as soon as it is made, at once begin to furnish the results which follow as a natural consequence from it. Nearly all important discoveries pass through a stage of neglect or obscurity. Either the public attention is already pre-occupied, or the discoveries come at a time when the public are not prepared for them, and they are disregarded, and may even disappear with their authors for a time, to come forward again with fresh force in after years, when the world is more in tune to receive them. Sometimes they pass through a stage of quiet development in the laboratory; laws are established, apparatus is devised to prove them, attention is drawn to them, public spirit is awakened, and from the higher level of the great discoverer flow new facts and new inventions, with astonishing rapidity, in many channels; the potential energy of the discoverer is transformed into energy of action in many directions, with more or less efficiency, according to the retarding state of the medium through which that action takes place.

The progress of electrical science in its several branches will afford abundant instances of these several stages. If, for instance, we regard the progress of telegraphy, we find that Sir Francis Ronalds, in 1816, showed that electricity could be practically used for conveying messages over long distances; yet so little notice is taken of his discoveries by the public and by the Government, who were no longer in need (so they said) of telegraphs after the battle of Waterloo, that he is almost driven to despair, and speaks of "taking leave of a science which once afforded him a favourite source of amusement," and of "bidding a cordial adieu to electricity."

It is remarkable that he should have said sixty years ago, "Let us have electrical conversation offices communicating with each other all over the kingdom," and yet the electric telegraph was not established until 20 years after (1837), and we are only now arriving at the system of telephonic exchanges.

In a private letter, written on his 72nd birthday, in 1860, he says, "If the electric telegraph of 1816 had been fairly examined, an effective instrument might have been in the hands of the Government, and after Dr. Oersted's experiments (in 1820), an improved telegraph might have been in their hands."

We shall also see other instances in connection with the special subject of my lectures, in which discoveries are neglected and passed by, because as we say, the discoverers were men who were in advance of their time, and in some cases the same discoveries are again made, and become known under another name. In 1815, Sir Francis Ronalds constructed an electric engine, which was set in motion by means of Singer's electric columns, and

as late as 1851 this engine was still in working order, when it was, I believe, at the Kew observatory.

In 1813, *i.e.*, when Ronalds was experimenting on the electric telegraph at Hammersmith, by means of his registering pith-ball electrometers, Sir Humphry Davy produced the electric light between two carbons, which were joined to the two poles of a powerful battery.

The following is a description of Sir Humphry Davy's experiments with the electric light:—

"Mr. Pepys having had the goodness to charge the great battery of the London Institution, consisting of 2,000 double plates of zinc and copper, with a mixture of 1,168 parts of water, 108 parts of nitrous acid, and 25 parts of sulphuric acid, so as to make an arc or column of electric light, varying in length from one to four inches, according to the state of rarefaction of the atmosphere in which it was produced, and a powerful magnet being presented to this arc or column, having its pole at a very acute angle to it, the arc or column was attracted or repelled with a rotatory motion, or made to revolve, by placing the pole in different positions, being repelled when the negative pole was on the right hand by the north pole of the magnet, and attracted by the south pole."

With a few cells of some of the more powerful batteries, such as Grove's, or Bunsen's, or the bichromate of potash battery we may readily reproduce the celebrated experiment of Sir Humphry Davy.

When Davy discovered the electric light in 1813, little was known of voltaic electricity, except that the current decomposed salts, and was always accompanied by chemical action in the battery. Davy had obtained the metals potassium, sodium, barium, strontium, calcium, and magnesium by the electric current. The relation between electricity and magnetism was still unknown.

In the year 1820, Oersted first observed the action of a current of electricity on the magnetic needles, and thus gave a very ready method of comparing the effects of different currents, by balancing these effects on the needles against the effect of the earth's horizontal magnetic force. In the same year Ampère discovered the law of the action of the current on the magnetic needles, and propounded his celebrated theory of magnets and of terrestrial magnetism. According to this theory, every particle of a piece of steel which forms the magnet has currents of electricity circulating round it in the same direction, and the magnetism of the magnet is only the resultant action of all these currents taken through the whole of the piece of steel. Thus magnetism is the resultant action of electric currents.

Ampère's experiments (which were repeated in the lecture) showed the mutual attraction and repulsion of parallel currents, and of currents and magnets; also that a current in a solenoid or in a flat coil, acts as a magnet; and that a hollow coil carrying a current attracts a core of soft iron and holds it up.

These elementary experiments are now very simple, and they may be very well known; but, as we shall see in the lectures which are to follow, some of these early and simple devices are found to be among the most efficient for controlling and regulating the current and steadying the light in some of the best electric lamps. Whilst Ampère was developing Oersted's experiment in one direction, Schweigger in the same year (1820) employed it for the comparison of currents, and invented the galvanometer. Then followed improved galvanometers by Becquerel and others; and in 1827, Ohm gave his simple theory of the action of batteries which was deduced from Volta's principle, and this has formed the groundwork of all later investigations of the subject.

If we consider these simple experiments of Oersted and Ampère in their relation to the now well-established principles of conservation of energy, we may arrive at some important conclusions which again are fully borne out by experiment. Thus, when a current of electricity passes along a wire in Oersted's experiment, part of its energy is spent in overcoming the resistance of the wire, and another part is spent in causing the motion of the magnetic needle, *i.e.*, in doing work upon it in opposition to the pull of the magnetic force of the earth upon it. This part of the energy, which is spent in twisting the magnetic needle about the axis, leaves less energy to be spent in producing the current, and so there is less current passing in the wire when the magnet is in the act of being deflected than there is in the same wire when there is no magnet. When the magnet is held at rest, or when it has settled into its position of rest, there is no longer any energy spent in keeping it there, and the full current again passes in the wire. Thus a current which deflects a magnet, is itself diminished by that motion of the magnet. Take again any of the simple experiments of Ampère on the mutual action of currents of electricity upon one another, and the motion of conductors carrying those currents. There is a conversion of energy of the current into motion of the conductor carrying the current in parallel wires attracting one another, and hence there is less current in the wire while the motion is actually taking place. Thus the approach of two wires carrying currents of electricity diminishes the currents flowing in the wires.

Now if the approach of these wires diminishes the currents in them, then the separation of the wires may be expected to increase the currents flowing in them, for in the separation work is done in the opposite direction. Hence, in the alternate approach and separation of the wires as they oscillate, the currents are diminished and increased alternately. If there be no current at all in one of the wires, then the separation of the two wires will give a current in the one which had no current in it, and the approach of the wires will give a current in the opposite direction. Thus we are led, by the well-known principles of energy, to results which are well-known to be true by experiment, that the separation of the parallel wires, one of which is carrying a current of electricity, produces in the other wire a current of electricity in the same direction or a direct current, and their approach produces a current of electricity in the opposite direction, or an inverse current.

Let us pursue this relation of the principles of energy to the effects produced by electric currents a little further. With two parallel currents in two approaching wires, the amount of energy used up, and therefore producing no effect in the shape of current, depends on the amount required or ex-

pended in bringing the wires together. This depends on the rate at which they approach one another. The more rapidly they approach, the more energy is consumed, and the more the currents in the wires are diminished.

In the same way, if the wires are separating from one another, the currents are increased by an amount which depends upon the rate of their separation. Hence, not only their relative motion, but the rate at which they approach and recede from one another, will determine the changes produced in the electric currents in them.

As in the case of bodies falling under the action of the force of gravity, the amount of energy expended is measured by the square of the velocity of falling, so, in the case of currents of electricity in wires approaching one another, the energy expended is measured by the square of the velocity of approach; so that the alteration in the current takes place more and more rapidly as the rate of approach is increased. If, again, we apply this to the case where one of the wires has a current in it, and a second parallel wire has no current in it as long as it remains at rest, then the amount or strength of the direct current in the second wire will increase at a more and more rapid rate as the velocity of separation of the wires is increased, and the strength of the inverse current in the second wire will increase at a more and more rapid rate as the velocity of approach of the wires is increased.

Here, then, we have the laws of the production of induced currents deduced according to the principles of energy from the relative motion of parallel currents, discovered by Ampère. These laws are of such importance in connection with the subject of these lectures, that I shall illustrate them a little farther by a few simple experiments, showing the effect of rate of approach or separation on the induction current.

Instead of actually removing the coils, if the current in the primary circuit be diminished, the effect is the same as if a wire carrying a part of it had been taken away, and so there is a direct current induced in the secondary wire, whereas, if the current in the primary wire be increased, the effect is the same as if a wire carrying the additional current had approached, and so an inverse current is induced in the secondary wire.

We shall get the greatest rate of separation by suddenly stopping the current in or breaking the primary current, and the greatest rate of approach by suddenly joining or making the current flow in the primary circuit. Hence, breaking the primary circuit produces a very intense rush of electricity, giving a direct current of great intensity in the secondary wire; and making the primary circuit gives a powerful inverse current in the secondary wire.

Having shown the relation between the production of currents of electricity by induction and the experiments of Ampère, as we should regard them at the present day in their relation to the principles of energy, let us now consider for a few minutes the way in which they were first produced.

It is now just fifty years ago since Faraday communicated to the Royal Society his first series of papers, entitled:—(1.) On "The Induction of Electric Currents;" (2.) on "The Evolution of Electricity from Magnetism;" (3.) on "A New Electrical Condition of Matter;" and (4.) on "Arago's Magnetic Phenomena."

Little did he imagine the marvellous results that were to flow from his experiments when he wrote, at the beginning of that communication, that he had been stimulated to investigate experimentally the inductive effects of electric currents, with the view of elucidating Ampère's beautiful theory of magnetism, and, in the hope of obtaining electricity from ordinary magnetism. In those papers he describes most minutely the details of his experiments, and unfolds, step by step, the laws of an induction current in a helix of wire, called B, placed near to another helix, called A, carrying a voltaic current. That, as long as a steady current was maintained in A, there was no current induced in B; that, on making contact in A, or on approaching the wires, there was a momentary inverse current in B, and, on breaking contact in A, or on separating the wires, there was direct induced current in B; that, as this current was of the nature of an electric wave, like the shock of a Leyden jar, it might magnetise a steel needle, although it produced slight effect on a galvanometer, and how his expectation was confirmed, and that the needle was magnetised opposite ways on making and on breaking contact.

Then, in his evolution of electricity from magnetism, he gives an account of the greatly increased effects on introducing soft iron cores into his helices of wire, and shows that similar effects are obtained by using ordinary magnets in place of a helix carrying a battery current round an iron core, *i.e.*, in place of an electro-magnet. Also, in place of a cylinder of iron in a helix of wire, he uses a welded soft iron ring, 6 inches in diameter, and 7-8ths of an inch in thickness, with helices wound round it—in fact, what would now be called a Gramme ring—and remarks that the iron cylinder arrangement was not so powerful as the ring arrangement. Placing the core within the helix, he magnetises it by bringing permanent magnets in contact with its ends, and observes "a deflection which indicates an induced current of electricity in the opposite direction to that fitted to form a magnet, having the same polarity as that really produced by contact with the bar magnets." Such a current would have converted the cylinder into a magnet of the opposite kind to that formed by contact with the poles A and B, and such a current moves in the opposite direction to the currents which in, Ampère's beautiful theory, are considered as constituting a magnet in the position figured. On bringing the bar in contact with the poles of the magnet, a current is induced in the wire in the direction indicated in the figure.

He then describes the experiment of introducing a magnet with a coil of wire, and shows that the same current is obtained whether the marked end of the magnet be introduced at one end of the coil or the unmarked end introduced at the other, and that a current is produced in the opposite direction to the former on withdrawing the magnet from either end.

Then after describing the method of producing his induction spark, and also muscular contractions in a frog by means of a loadstone and coils, which were lent to him from King's College, and remarking that the intensity of the effect produced

depends upon the rate of separation of the coil from the poles of the loadstone, he concludes this section thus:—"An agent which is conducted along metallic wires in the manner described, which, whilst so passing, possesses the peculiar magnetic actions and force of a current of electricity, which can agitate and convulse the limbs of a frog, and which finally can produce a spark, can only be electricity."

One other of the discoveries of Faraday, made in that memorable year 1831, we shall find to be of great importance in magneto-electric machines, viz., the difference of time between induction by a battery current in a coil and induction by a magnet, which requires a considerable interval of time to get up to its full strength. Faraday accounted for this retardation by supposing that there is a redistribution of the Ampèrian currents in the iron itself, so that the magnet requires time to rise to its full power.

We may well consider for a while the work of such a man, who, fifty years ago, in his first series of papers to the Royal Society, could establish so many laws of magnetic and current induction, and who made possible the rapid development which is now going on in the science of electricity, and especially in the production of magneto- and dynamo- machines.

MISCELLANEOUS.

NOTES ON AMERICAN SCIENCE AND MECHANISM.

The Composition of Comets' Tails.

The science of spectroscopy is known to have made some advances in the United States, and a few of its citizens are justly considered to be entitled to speak on such subject with authority. Professor Wright, of Yale College, has, among others, bestowed much attention upon the comet, and has just published some of his results, and the deductions he makes therefrom. He finds that the light emitted by the tail of the comet is polarised, rather strongly, in a plane passing through the sun's place. Not only has he fixed the direction of the polarisation, he has also measured its amount. From his experiments he infers that a large portion of the light of a comet's tail is reflected sunlight, and the amount being greater than if the reflecting material were composed of solid masses, indicates that the matter of the tail is in the form of gas or vapour. Spectroscopic examination proves that the comet shines partly by its own light, and partly by that derived from the sun. The origin and nature of the gaseous matter which forms the tail may be inferred from the results of recent discoveries concerning the relation between comets and meteorites. Former investigations made by Professor Wright indicate that meteorites contain large quantities of gas, with a considerable proportion of water, and that at a temperature far below that of red heat, gas is given off at a rate of from one to over two inches for every cubic inch of the meteoric substance, beside the water vapour. The gas is a mixture of hydrogen, carbon dioxide, and carbonic oxide, the two latter in the greater proportion, with a little marsh gas and nitrogen. Inclosed in a vacuum tube, at low pressure, and made luminous by an electrical discharge, the meteoric gases give a spectrum, which, under suitable conditions, is essentially the same as the usual cometary spectrum of bright bands.

The American Railroad-car versus the Compartment Carriages.

The alleged advantages of the American railroad-car over the close compartment system preferred in England is being much discussed here, in consequence of an assasination which lately took place in one of the latter. It may possibly be claimed by those favouring the compartment system, that with such a construction of carriages no such outrage could possibly have taken place as that which is, at this moment, the leading theme in American newspapers. In a part of the country which, Dr. Russell will be telling you, abounds in lawlessness, a railway train left a station, Winston, on the Rock Island and Pacific Railroad, about nine o'clock at night on the 15th inst., when it was boarded at every point by a band of twelve well armed and thoroughly experienced desperadoes. Two jumped on the locomotive, and drove off the engineer and fireman at the revolver's muzzle. Others by similar means prevented the interference of the passengers with their schemes, while the remainder devoted their attention to the safe in which valuable property was contained. There was also some bullion in the form of bricks of silver. Several shots were fired at non-complying or resisting officials, the conductor being killed. No attempt was made to rob the passengers. Now, when the character of the attacking party is considered, it will be seen that such an outrage might have been made not only on a train of compartment carriages, but on one going over even the North London or Metropolitan Railways. The band is composed of old experienced hands, well-known in connection with innumerable deeds of daring, possessed of desperate courage; they have a perfect acquaintance with all the western country between Iowa and the Indian Territory. Their operations are conducted on a large scale, and are almost invariably successful. Their leader is one or the other of the two James brothers, whose mother, now Mrs. Dr. Samuels, is credited with the planning of the outrages so boldly carried into practice by the gang, who must not be compared with the sneaking banditti in Sicily or Greece, as will be seen by the following few examples out of numerous others of a like nature. In 1868, desirous to give a "benefit" to a sick member who wished to go to the seaside, a party of about a dozen, well mounted, dashed into the town of Russellville, Kentucky, during business hours, drew up in front of the bank, and "covered" with their revolvers the townsmen who were passing while two went in and robbed the bank. The following year a similar feat was accomplished in Galanta, Mobile, on which occasion they shot the cashier. Two years afterwards, in 1871, this was repeated, including the shooting of the cashier, in Columbus, Kentucky; and in 1872 a party of six of the gang did the same in Corydon, Iowa. In the same year, and while there were 20,000 people present at the Kansas City Exhibition, they made a successful raid on the cashier's office. They have robbed many banks and the express cars of several trains, and on at least one occasion of the latter nature they impudently sent a telegraphic despatch to the St. Louis newspapers reporting the occurrence before they rode away. Several members have been shot down during hot chases and conflicts with the inhabitants, but no one, even when dying, has ever yet told who his companions were. The recruits are selected from the guerillas of the Southern Confederacy. Many stories are told of their exploits, and these stories, although wonderful, are said to fall short of the reality. Among those who have been shot by them are six detective officers, three of whom belonged to Pinkerton's Detective Agency, New York. Why I have entered at such length on the *personnel* of the gang is this—In the Society of Arts sooner or later the subject of the assimilation of English railway carriages with those of America will be brought forward, and it is more than likely that those unfavourable to the American system will cite the recent robbery as

one which could not have been enacted in close compartment carriages. But from what I have said of the James gang, it will be apparent that the nature of the carriages would prove no barrier to such raiders, and it is, further, unfair to base any argument upon their doings, for in England such a band could not possibly exist.

The Electric Light and the Cost of Gas in America.

The gas companies and the electric light companies here are watching each other very closely. No longer alarmed at the outcry that the electric spark was to provide a brighter, safer, and cheaper light than gas, and the panic in gas stocks having subsided, the companies which control carburetted hydrogen observe, with much satisfaction, that the electric light companies are fixing their prices for service on the basis of the present exorbitant charges for gas, which I may state now costs in New York two and a quarter dollars (about nine shillings and fourpence halfpenny) per thousand feet. At present there is no indication that the electric light will be supplied at quite so cheap a rate, although orders are pouring in faster than they can be filled. Now, while many are guided by the novelty and beauty of the new light, and are willing to pay a little more for it, the great majority of the public will be guided by considerations of cost, and will not be readily tempted to incur the expense of fittings for the electric light. By keeping the price of gas so greatly in excess of what the companies admit that it can be sold, these companies are allowing the electric light to obtain a footing from which it may not eventually be easy to dislodge it, more especially if by recent and forthcoming inventions connected with the storage of electricity the prices be reduced, an idea apparently ignored by the gas companies. The more probable theory is that, believing in the ultimate practicability of the electric light, the gas companies will adhere to their present high prices until the electric opposition makes itself too strongly felt, when, all at once, the price to consumers will be reduced to such an extent as will cause the rival bodies to stagger. That this can be done is apparent from the fact that coal is dearer in London than in many places in this neighbourhood; for example, in Philadelphia, where coal is 4s. 2d. cheaper per ton than in London, but where gas costs three times as much as in London. This high price, in the large American cities, arises from there being no competition in the making and supplying of gas as there is in other necessaries or luxuries of life. That a good dividend could be paid at 75 cents. (3s.) per thousand feet is not denied, and the great hope of the public now is, that by improvements in electric lighting, gas may come to be reduced to this price.

New Method of Storing Electricity.

An Ohio electrician, Mr. Charles Brush, of Cleveland, having for several years been engaged in devising means for storing electricity, has now had his labours crowned with success, the means by which he effects this being different from that of M. Faure, which is based on the invention of Planté, several years prior. Brush may or may not have obtained results equal to Faure some years ago, as he claims to have done; what is of more importance to us is the fact that the details of the American invention are quite different from those of either of these French inventors, and do not infringe upon their rights. Although the full details have not yet been published, I am still able to state that the storage reservoirs are metal plates capable of receiving a large charge of electricity, and of retaining it for an indefinite time. Being made of varying dimensions, and being quite portable, they may be sent around day by day, and delivered to the consumers from a waggon, in much the same way as such necessaries of life as milk, bread, or ice is now supplied. If only one half of what Mr. Brush's friends say of his invention be true, the application of electricity in a convenient and economical manner to lighting, motor, and, indeed, to every thing to which electricity is applicable, is now in a fair way of making a rapid approach. Those who know the inventor aver that he is a man who says nothing of his work until he is satisfied with it, and this says a good deal for the value and merits of the present invention. J. T. T.

New York, July 18th, 1881.

THE SOY BEAN, A NEW FEEDING STUFF.

By C. G. Warnford Lock.

The soy bean of China and Japan, *Glycine soja*, (*Soja hispida*), sufficiently familiar as the source of the Eastern sauce of that name, and affording a valuable oil (bean oil), which is the subject of an article in the new "Industrial Encyclopædia" (Spons), is attracting considerable attention among Continental agriculturists, and has recently been experimented on with regard to its value as a food for milch cows and fat cattle.

The beans were first given alone, to test the effect. The cattle took them very readily, but too large a quantity of saliva was required in their mastication, and it was found better to mix them with the root food.

First, as to the results with milch cows. These were divided into two parties. During the first stage of the experiment, when the cows received no forcing food, they gained 1·15 lbs. in weight, and gave an average of $10\frac{1}{4}$ pints of milk each per diem. During the second stage, when the first portion of beans was given to half the cows, their weight increased by 1·21 lbs., their milk by ·17 pint, and the cream by $1\frac{1}{2}$ per cent. The other half of the cows, which received grains instead of beans, grew 1·93 lbs. in weight, and fell off ·33 pint of milk each per diem, with no difference in the percentage of cream. In the third stage, the cows that had had beans in the second stage were put upon grains, with the result that their weight increased only ·72 lb., and the milk yield fell off 1 pint each pe[r] diem, while the cream increased $\frac{1}{2}$ per cent. The other half of the cows, which had had grains hitherto, on receiving beans, increased 1 lb. in weight, but the milk yield fell off ·61 pint each per diem, and the crear increased by $1\frac{1}{4}$ per cent. In the fourth stage, the feeding was again reversed. The cows which last hac grains, on receiving beans, increased ·59 lb. in weight 2·34 pints in milk yield, and $2\frac{1}{4}$ per cent. in cream, eacl per diem; while those which returned from beans t grains fell off ·66 lb. in weight, and 1·86 pints in mil yield, though the cream increased $1\frac{1}{4}$ per cent.

The fattening cattle were also divided into two lots During the first stage without fattening food, one lo increased in weight 72·73 lbs., being ·64 lb. each pe diem; the other only ·11 lb. each per diem. This grea difference was owing to exchanges of the cattle. I the second stage, the lot which had beans increase 22 lbs., or ·19 lb. each per diem; those which got grain instead increased 158·68 lbs., or 1·41 lbs. each pe diem. During the third stage, the lot receiving grain grew 185 lbs., or 1·65 lbs. each per diem; those receivin beans fell off 39·67 lbs., or ·35 lb. each per diem During the fourth stage, the lot returning to grain grew 77 lbs., or ·68 lb. each per diem; while the other increased only 55 lbs., or ·49 lb. each per diem.

The figures of the second and third stages of th experiment show that the average results were:- Increase of weight per head per diem, with bean die 2·18 lbs.; with grains, 2·66 lbs. Loss of milk pe head per diem, with bean diet, ·44 pint; with grain ·72 pint. Gain of cream, with bean diet, $2\frac{3}{4}$ per cen In the case of the fat cattle, the loss in weight each pe diem by bean diet was ·15 lb.; the gain by grain 3·06 lbs. (It should here be remarked that the ter "loss" must not be taken as meaning actual loss, bu rather retrogression in gain.) As a forcing food fo

milch cows, therefore, the soy bean is superior to grains; for fat cattle, it is less adapted, and ranks second to grains.

The plant can be cultivated in Central and Eastern Europe, and similar localities, especially in unfavourable years, when other crops are backward. For growth as a field crop, it is recommended to be sown in rows 18 in. apart in the middle of May.

The qualities of the beans grown in diluvial and alluvial soils are shown by the following analyses:—

	Diluvial.	Alluvial.
Water	15·20	13·50
Fat	16·21	17·94
Protein	28·63	25·94
Non-nitrogenous extractive matter	30·84	33·16
Fibre	4·38	4·45
Mineral matter	4·74	8·82

The straw or haulm of the plant is practically worthless for neat cattle, but the husks and leaves, mixed with mashed food, or even alone, are readily eaten. It has also been found that the chopped beans, soaked for 12 hours in water containing a little salt, are greedily taken by cattle, and that few pass through undigested.

THE EXPLOSIVE POWERS OF DUST.

A report has been presented on the results of experiments made with samples of dust collected at Seaham Colliery, in compliance with the request of the Home Secretary, by Prof. F. A. Abel, C.B., F.R.S., Chemist to the War Department:—"The results of the experiments with Seaham and other dusts appear (says Mr. Abel) to have demonstrated—(*a*) That coal-dust in mines not only much promotes and extends explosions in mines, by reason of the rapid inflammability of the finely-divided combustible, and of the readiness with which it becomes and remains suspended in air-currents, but (*b*) that it may also be itself readily brought into operation as a fiercely burning agent which will carry flame rapidly as far as its mixture with air extends, and will operate even as an exploding agent, through the medium of a proportion of fire-damp in the air of the mine, the existence of which, in the absence of the dust, would not be attended by any danger. (*c*) That dust in coal-mines, quite apart from any inflammability which it may possess, can operate in a distinct manner, as a finely-divided solid, in determining the ignition of mixtures of only small proportions of fire-damp and air, and consequently in developing explosive effects. (*d*) That a particular dust in a mine may, therefore, be a source of danger, even though it contains only a small proportion of coal or combustible matter. Although the explosion which may occur through the agency even of a non-combustible powder, in the manner described, may be of very mild or feeble character in the first instance, it may be almost at once increased in magnitude and violence by coal-dust, which the first ignition will raise and bring into action. The proportion of fire-damp required to bring dust in a mine into operation as a rapidly burning or an exploding agent, even upon a small scale, and with the application of a small source of heat or flame, is below the smallest amount which can be detected in the air of a mine, even by the most experienced observer, with the means at present in use, as has already been demonstrated by the experiments of Mr. Galloway. Indeed, with dusts of highly sensitive or dangerous character, under those conditions, and very possibly with dusts not more so than the least sensitive of the Seaham samples, in the presence of a source of considerable heat and flame, such as blown-out shot or an overcharged hole would constitute, a small proportion of fire-damp, the possible existence of which in the mine might not be in the least suspected, may serve as the inciting cause to the development of an explosion of coal-dust. In the complete absence of fire-damp, coal-dust exhibits some tendency to become inflamed passing a very large lamp flame at a high velocity; if exposed to the action of a large volume of flame, such as produced by the explosion of freely exposed gunpowder or gun-cotton, it exhibits, in addition, a decided tendency to carry or propagate flame. But, so far as can be determined by experiments on a moderate scale, this tendency is of limited nature, and very different indeed from the property of carrying or propagating flame, which even comparatively non-sensitive dusts possess in the presence of a very small quantity of fire-damp. In conclusion, it may be admitted as possible that, with the large volume of flame and the great disturbing effect of a blown-out shot as the initiatory cause of the ignition of dust, and its suspension in the surrounding air, such inflammation may, in the complete absence of fire-damp, be propagated to a greater distance than the results of small experiments would warrant one in assuming. But it can scarcely be maintained that the air of a mine in which the coal gives off gas at all can be at any time free from fire-damp; and as the existence of very small and unsuspected quantities of that gas in the air of a mine may suffice to bring about the ready propagation of flame by coal-dust, and thus to develop violent explosive effects, it would appear needless to assume that coal-dust may, in the entire absence of fire-damp, give rise to explosions, even of only limited character in coal mines, in order to account for casualties which cannot be ascribed to the existence of accumulations or sudden outbursts of fire-damp."

THE SALT CAVES AND MINES IN THE PERSIAN GULF.

From a recent report by Assistant-Surgeon Abder Rahem, it appears that in that part of the Persian Gulf lying between latitude 26° 10′ and 27° 10′ N. and longitude 53° 50′ and 56° 30′ E., is an extensive area, abounding in a large deposit of salt, which crops out at various places on the earth's surface, rising up into ranges of rocks of no little magnitude. The following are the principal places from which salt is obtained in this area:—Kowin, on Kishm Island, Hormuz, Larak, Pohal, near Khamir, Sir-bu-Nafair, Jabal Bostana, and Hameran, on the Persian coast. The salt-bearing rocks are of a reddish colour, from red ochre, varying from earthy consistence to stony hardness, which covers the salt deposit, and is more or less mixed with it, imparting to it a red tint. The ochre is associated, to a small extent, with specular iron ore. The association of the ochre with salt is so constant in the salt area that the existence of the former is almost a sure indication of the presence of the latter. About 16 miles from the Bassidore Station in a south-easterly direction, and three miles from the village of Kowin, on the island of Kishm, is a range of rocks bordering on the sea, and consisting very largely of rock salt covered in some parts by red ochre, while in others large masses of salt of stony hardness and reddish tint compose the surface and mass of this rock, giving it the appearance of a structure made of red bricks and mortar. A salt cave is situated in the western end of the range of rocks, and besides this there are several other places where briny water issues, and collecting in hollow ground close to these rocks, deposits beautiful crystalline masses of salt by spontaneous evaporation. It is stated that some forty years ago, the salt was largely procured by this method; numerous shallow pits were excavated, where, as the brine evaporated, it deposited salt, which was then collected for commercial purposes; but since the natives commenced to quarry the salt, the pits were neglected, as the process was tedious, and the salt obtained, little in quantity, and not good in quality for commercial purposes; at the present time, however, the streams of brine and some of the pits still exist, and

yield a certain quantity of salt for home consumption. The working of these salt mines during the past thirty or forty years has given rise to large caverns in the bowels of the rock. In almost all these caves, from the trickling of the brine, stalactites of various shape and magnitude are formed, yielding snow-white masses of salt of saccharoid description. The salt is found in four principal forms. First, pure white masses, easily reduced to granules; second, red masses of stony hardness; third, saccharoid masses, from trickling of brine; and fourth, translucent and transparent masses of cubical forms. The granular form is the most valuable, and is generally of a pure white colour; the red hard blocks are principally used by the natives for salting fish. The salt is dug out by means of of crowbars, and it is by no means uncommon during the working of the mines for people to be buried alive from earth-falls. The mines which yield the present salt are situated about two miles from the seashore, and the path leading to them winding between the rocks is very difficult for the camels to traverse. The salt is brought on the beach by the camels, costing about 4s. for every "bahar," or ton and a-half, and calculating the customs charges at 1s. 6d., and the cost of quarrying at 5s., the total cost of the salt on the beach would be about 10s. 6d. per ton and a-half. Recently salt of an excellent quality was quarried from the rocks, about 100 yards only from the seashore, thus saving the cost of carriage to the miners. The salt mines at Hameran are also extensive. They are situated about four miles from the seashore, and the salt is found in beds of about 4 ft. thick, with intervening layers of earthy material. The salt beds are hard in consistence, and are broken by means of gunpowder, the masses being subsequently reduced to granules by wooden and iron mallets. Some of the specimens found were of a pale greenish colour, from an earth of that tint. This earth exists in isolated deposits and mounds, varying from earthy softness to stony hardness, the green tint being produced by the influence of manganese. The quarrying expenses at these mines are about 5s. each ton and a-half, camel hire amounting to about 4s. 6d., and boat hire to Lingah being about 3s. Large quantities of salt are exported by native boats to Muscat, whence it is carried by merchant vessels to Bengal, Zanzibar, Mauritius, Batavia, &c. There is an average annual export of from 25,000 to 30,000 tons of salt from these mines, the best quality coming from the Kishm Island and Sir-bu-Nufair. The price of salt at Lingah varies from 4 to 5 dollars, while at Muscat it is from 5 to 6 dollars per "bahar," or ton and a-half. There are, in addition to these caves and mines, certain springs in the rocks close to the village of Salakh, near Henjam, the waters of which are warm, and charged with salt, yielding naphtha of a reddish colour. It is highly combustible, burning with thick smoke. The natives use it for purposes of light, and also use it locally for rheumatic complaints.

JAPANESE LACQUER AND PAPER.

The manufactures of lacquer and paper, two industries for which the Japanese are deservedly celebrated, were made special objects of study by Sir E. J. Reed, on his recent visit to the Flowery Land, and the following notes are mainly taken from his interesting volumes :—

The Japanese lacquer is laid usually upon articles of wood, and not upon articles of *papier-maché*, as many suppose. It is produced from the sap of the *Rhus vernicifera*, which is taken in its natural state into a large wooden tub or vat, and then stirred in the sun with a large spatula, until its excess of water is evaporated. In some cases the varnish so produced undergoes careful straining; in others, it is mixed with sulphate of iron, with vermilion, with red oxide of iron, or with indigo; oil is sometimes employed, likewise powdered stone. Into some inferior varnishes, a sort of paste made of rice enters in considerable proportion. There are a dozen methods of employing the various varnishes, differing according to the nature of the object to be produced. In the best lacquer, numerous coatings are applied, dried, and polished successively. The first polishings are done with a stone named *tsu shimada* (suitable for hones), the later by means of water, and a charcoal made from *Andromeda ovalifolia*, and the last with pulverised stag's horn. All the polishings are effected by the hand. When gold is used in smooth-surface lacquers, where it is not to be in relief, the process is as follows:—The design to be produced is traced on a leaf of paper, which is then reversed, and has repeated upon the opposite side of it the outlines and other features of the design, in a mixture of varnish and vermilion, softened over a mild fire. This side of the paper is then applied to the lacquer to be decorated, and the paper is rubbed and pressed upon it by means of a small spatula of bamboo. The transfer of the pattern from the paper to the lacquered surface is further assisted by gently beating the paper down with a small silken bag, containing powdered stone. The paper is then peeled off, and can be used again if desired. Th[e] slight relief of the pattern so produced upon th[e] lacquer is rubbed down with carbon polish, and th[e] design, and that alone, is then lightly covered with a thin layer of quickly-drying varnish. Gold, in powder is then applied to the moist surface by means of a camel-hair pencil if the gold powder be fine, and by means of a small tube if it be comparatively coars[e] and heavy. The article is then dried for a day in a warm closet, such as is used for drying the ordinary lacquer varnish. The design is next lightly coate[d] with a very thin layer of varnish, applied by mean[s] of paper steeped in it, and passed very delicately over the object, which is then redried in the closet. The object receives further extremely light coatings o[f] varnish, and subsequent polishings before it is com[-]plete. Silver is applied in powder in the same manner. When gold or silver is applied to designs in relief, th[e] details of the process vary considerably, but th[e] application of the metals is effected in substantially th[e] same manner. When gold and silver are applied i[n] leaf, they are laid upon the varnished surface prepare[d] for them, and dealt with in the usual manner, th[e] varnish acting as a "size" for the metallic leaf. Whe[n] mother-of-pearl is used as an incrustation for lacquer, it is laid on during the varnishing processes, earlier i[f] it be thick than if it be thin, and the final polishing i[s] proceeded with until the pearl is brought to the surface.

Paper.

Besides the papers made from rags and rope-wast[e] by European methods, the true Japanese papers ar[e] produced from a limited number of materials, the chie[f] kinds being *Hishi*, from the *gampi* (*Wickstrœmia canes-cens*) and allied plants, and *Kokushi*, from the *kozo* *kodzu*, or paper-mulberry (*Broussonetia papyrifera*), which latter is the more important. The treatment o[f] the *kozo* plants for paper-making purposes is as follows:— They are cut into 3-feet lengths, and steamed in a larg[e] boiler containing a little boiling water. The bark i[s] then peeled off, and steeped in water; the dark oute[r] skin or rind is scraped off with a knife, and the scraping[s] are used to make inferior paper. The scraped an[d] cleansed bark is carefully washed in running water and then exposed to the sun until bleached sufficientl[y] white. After this, it is boiled in a lye formed wit[h] buckwheat ash, to remove gummy and resinous sub[-]stances. The fibres are then readily separated. Afte[r] cutting out knots of excessive hardness, the workme[n] beat the fibre into a pulp with wooden mallets upo[n] blocks of stone. This pulp is united in tubs or vat[s] with the needful quantity of water, to which is adde[d] a milky substance prepared with rice-flour, and

gummy decoction from the bark of the *nori-noki* (*Hydrangea paniculata*), or from the root of the *tororo* (*Tororo hibiscus*). When the steeping in this mixture has proceeded sufficiently long, the pulp is spread out into sheets by means of fine sieves of bamboo and silk. After draining, the sheets are transferred by means of brushes to drying-boards.

Similar processes are employed for producing paper from the *gampi*. The product is very fine and supple, and admirably suited for taking transfer copies, besides possessing the advantage of not becoming worm-eaten. Paper is also made from the *mitsu-mata* (*Edgworthia papyrifera*).

CEYLON PEARL FISHERY.

The pearl fishery which has just closed in Ceylon has been one of the most successful on record. The pearls procured from the oysters on the banks situated off Silavaturai, on the western coast of that island have been famous from time immemorial for their purity, shape, and colour. In these attributes they far surpass those obtained from the oysters of the Persian Gulf, although they are, as a rule, inferior to the latter in size. The oyster of the Arippu banks is scientifically known as the *Meleagrina margaritifera*, and is of a species not existing on all pearl oyster banks, and of a different genus altogether to that found in the Tamblegan Lake, near Trincomalee, on the eastern coast of the island, which is termed the *Placuna placenta*. The earliest fishery of which we can find any detailed record took place in the year 1796; and from that date the Ceylon Government, up to the year 1874, derived a sum of £1,013,113 from this source. The pearl oyster is curiously migratory in its habits; and from one cause or another the banks are for years together almost totally deserted by them, and long intervals elapsed during which the fishery has from this peculiarity been closed, rendering the return from it quite unreliable as a source of settled revenue. Thus from 1732 to 1746, from 1768 to 1796, and from 1833 to 1854, there were no fisheries at all, and it was feared at the latter date that the oysters had altogether deserted the banks.

A few words descriptive of the system under which a fishery is conducted will be of interest. A report having been received from the inspector that there are sufficient oysters of mature age on the banks, the Government advertises a date for its commencement. A large number of boat-owners, both Ceylonese, and from the opposite coast of India, apply to enrol their boats, and these, probably to the number of 150 to 180, are divided into two fleets, sailing under red and blue flags, which proceed to the banks, situated some six miles from the shore, on alternate days. Each boat provides its own crew and divers, and has on board a guard, whose duty it is to see that the oysters fished are not surreptitiously disposed of. Each diver stands on a flat stone attached to the diving rope, and after taking a long inspiration, closes the nostrils with one hand, and descends on the stone to the bottom, where he hastily collects as many oysters in his basket as the time he is able to remain at the bottom admits of. This varies very much with the capacity of different men; but, in spite of all assertions to the contrary, we believe that few divers can stay below beyond 45 seconds. At a given signal the boats all sail for the shore, and on their arrival they are unloaded under inspection, and the oysters placed in the Government kottoos—palisaded enclosures with a cement floor. Here the oysters are counted, and the proportion due to the boat-owners for their services is made over to them. The remainder, which is the property of the Government, is put up to auction and sold to the highest bidder. The purchasers remove their lots to private kottoos, where the oysters undergo the disagreeable process of rotting, to enable the pearls to be washed out. The stench resulting from this decay is fearful, and it has often happened that the operations have had to be prematurely closed in consequence of the resulting outbreak of cholera. It says much for the careful sanitary arrangements made by the officials in charge that such outbreaks are not of recent occurrence.

The official estimate of the proceeds to be expected from this year's fishing was 400,000rs.; but this estimate has been considerably exceeded, the returns having been 599,333rs. To some considerable extent this increase is due to the improved demand in India for pearls, the competition having been very keen. As yet, official returns have not been published; but the *Ceylon Observer* has kept its readers very fully informed of the results of each day's fishing, and of the prices obtained. The total number of days on which the weather and other conditions allowed of operations being conducted was forty, and the fishing finally closed on April 27. The number of oysters fished during that period is reported to have been about 17,000,000, and the average price realised for them about 34rs. per thousand, though they occasionally brought as high prices as 43rs. per thousand.—*Colonies and India.*

CORRESPONDENCE.

A NEW THEORY CONCERNING BOILER EXPLOSIONS.

Referring to the last paragraph, p. 727, in the *Journal* of the 5th inst., on "A New Theory concerning Boiler Explosions," it is just 40 years since I saw the new high-pressure steamer *Telegraph* leave the Custom House, at Greenock, with a large party on board, for Helensburgh, on the opposite side of the Clyde. Watching her anxiously with a glass, I noticed that she arrived safely at the small quay or landing-place then existing there, but immediately after she was literally blown to pieces by the bursting of the boiler, which was hurled completely over the quay. Many persons were killed, and many more seriously injured.

I mention the occurrence as it may enable any of my brother members who may desire full details to obtain them.

John Wm. Wood,
Collector of Customs.

H.M. Customs, Harwich, Essex.
August 6th, 1881.

TURKISH OFFICIAL STATISTICS.

Two interesting and noteworthy subjects appear in the *Saalnamí*, or Official Almanack in Turkish, of 1296 (1881), a Year Book published at the Ministry of Public Instruction. The one is a statistical account of the exports and imports in Turkey proper for the year 1294 (1878), and the other is a census of the male population of the Empire, as well as the enumeration of dwellings in each Vilayet. The value of the former is particularly enhanced in consequence of the detailed statement of the commercial movement which took place with each country separately with which Turkey stands in commercial relations, and because it is the first work of the kind published by the Government. It will be observed that England figures in these accounts for over $\frac{11}{24}$ of the entire amount.

Bearing in mind too that the general commercial movement, as shown in the following table, cannot be taken as a normal standard of the commerce of this country, 1878 was the year when the Turco-Russian war was terminated; a great part of the Mussulman able male population were kept under arms for two consecutive years, which deprived agriculture of its hands; while some of the richest provinces of the Empire were devastated by the war, locusts, and famine, this must have caused a diminution in the

general exchange of at least one-third. The second part, viz., the census of the population, although incomplete, is yet interesting in so far as it gives an approximate idea what the population of Turkey proper is, or, at all events, what the *Saalnamí* assumes it to be.

Without entering into the accuracy of the following items, I will merely confine myself to reproduce the statements of the *Saalnamí*.

TABLE I.—Statement of Imports and Exports for the Year 1294 (1878).

Imports.

Names of Countries.	Value of Merchandise.	Custom-house Duty Levied.
	Piastres.	Piastres.
Spain	2,461	245
England	971,067,606	70,238,401
Austria, Hungary	282,515,715	20,350,786
Italy	56,992,450	3,815,408
Belgium	8,075,290	581,120
America	41,629,333	2,997,209
Persia	54,909,960	8,665,008
Russia	142,390,942	10,259,417
France	325,292,148	23,423,056
Holland	11,007,695	793,026
Greece	31,901,739	2,512,914
Egypt	..	..
Tunis	797,184	57,297
Roumania	62,047,596	3,157,322
Samos	196,950	14,402
Bulgaria	7,768,060	559,299
Sweden	509,465	36,681
Prussia	2,483,399	252,955
Germany	1,328,132	108,334
Servia	6,361	458
Total Piastres	2,000,922,486	147,823,338
Or Lira Turca	20,009,224 86c.	1,478,233 38c.

Exports.

Names of Countries.	Value of Merchandise.	Custom-house Duty Levied.
	Piastres.	Piastres.
Spain	252,441	2,272
England	352,177,010	3,172,403
Austria, Hungary	91,975,996	737,778
Italy	14,236,884	128,233
Belgium	6,888	62
America	9,112,633	82,013
Persia	5,255,044	163,380
Russia	34,375,036	310,289
France	256,560,576	2,309,142
Holland	3,351,649	30,165
Greece	32,163,140	306,042
Egypt	48,439,008	3,478,488
Tunis	139,835	10,018
Roumania	563,757	40,029
Bulgaria	348,461	25,057
Sweden	1,888	17
Prussia	390,239	3,513
Total Piastres	839,350,485	10,798,901
Or Lira Turca	8,393,504 85c.	107,989 1c.

Gross total of exportation and importation, Lira Turca 28,402,729 71c.; duties levied, Lira Turca 1,586,222 39c. In ordinary times the external commercial intercourse of Turkey can certainly not be less than £40,000,000.

TABLE II.—Statement of the Number of Male Population and Buildings.

Names of Vilayets.	Number of Male Population.	Number of Houses.
Constantinople*	..	66,984
Broussa	503,033	204,170
Syria †	382,350	158,851
Archipelago ‡	146,579	69,413
Djanik and Trebizond	459,122	187,745
Angora	342,000	127,100
Sivas	327,666	124,998
Aleppo	308,895	130,000
Adana	170,000	68,660
Ismid and Bigha (dependency of Constantinople)	125,832	52,419
Konia	390,098	157,124
Castamouni	315,111	109,933
Aidin (Smyrna) §	387,189	191,045
Diaribekir §	324,843	138,920
Jerusalem	90,192	29,516
Yanina	389,251	147,147
Salonika	452,623	182,260
Terhala	123,183	49,257
Monastir §	272,659	105,771
Cossova §	181,310	59,105
Adrianople	163,126	134,605
Erzeroom §	176,850	65,726
Van §	17,310	5,843
Bitlis §	49,096	21,529
Total	6,098,318	2,583,121

Assuming the male population of Constantinople to be 350,000, and allowing for the incomplete census of certain Vilayets, as well as Bagdad, Tripoli in Barbary, &c., the entire population of Turkey proper may very likely amount in round numbers to *sixteen millions*, including the female sex.

S. Stab,
Cor. Memb. Society of Arts.

Constantinople and Smyrna, 27th May, 1881.

GENERAL NOTES.

Commercial Geography.—A letter has recently appeared in the *Times* from Mr. E. J. Watherston, advocating the establishment in this country of institutions similar to those working in Germany, under the titles of "Societies of, or for, Commercial Geography"—"Vereine für Handelsgeographie." The objects of these societies are—first, to give their members information regarding the channels into which the export trade of the country should be directed; secondly, to establish agencies in all the principal commercial towns in the world. This is done after the model of Lloyd's. In like manner as Lloyd's agents report concerning ships, shipwrecks, and all matters relating to navigation, to the head quarters in London, so the German agents send in reports upon all matters relating to the commercial rquirements of their districts to the "Centralverein für Handelsgeographie" in Berlin, which reports are published in full in the "Geographische Nachrichten," sold to non-members for the sum of two marks, or 2s. The list of agents includes some of the most eminent Germans settled abroad, men of scientific renown, anxious for their country's welfare.

* No census yet made.
† Exclusive of Hauran.
‡ Some islands not completed yet.
§ Not completed yet.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, is now open daily. A non-transferable season ticket will be sent to any member of the Society on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE SCIENTIFIC PRINCIPLES INVOLVED IN ELECTRIC LIGHTING.

By Professor W. Grylls Adams, F.R.S.

Lecture II.—Delivered March 14, 1881.

The measurement of electric currents.—Efficiency of magneto- and dynamo-electric machines.—Heating effects of the current.

After the discovery of the principles which I explained in the last lecture, and the method of producing currents of electricity by the inductive action of magnets, or currents in motion, the laws of these currents were being developed; but, for twenty years after Faraday's discovery in 1831 that the sudden removal of a coil of wire from the pole of a magnet gave rise to a current, nothing was done to apply these laws for the purposes of electric lighting. Voltaic batteries were being improved, and the more constant and more powerful batteries of Daniell, and Grove, and Bunsen were discovered, and these were the sources employed to produce the more powerful currents of electricity. In this country Grove's battery was the favourite; and in our laboratories we may say that, up to the present time, the 40 or 50 cells of Grove have always been used to give us the electric light.

When used for optical experiments in the laboratory, the source of light should be as steady as possible, and as the carbons burn away, their points should be continually brought to the same position; hence the elaborate arrangements of wheel work and electro-magnets devised by Staite, in 1847, and by Foucault, which have reached very great perfection in the hands of Duboscq.

One of the carbons, that connected with the positive pole of the battery, burns away twice as fast as the other, and hence the wheel-work must be adapted for feeding these carbons automatically at the proper rate.

When the current flows always in the same direction in the arc, as in this case where Grove's battery is used, and in all cases where the magneto-machine is adapted for producing continuous currents, the positive charcoal point or carbon becomes hollow, and wears away more rapidly; and the negative carbon becomes pointed, and wears away about half as fast.

In the Duboscq lamp, the positions of the points of the carbon are kept as nearly as possible the same; the carbons are moved towards one another by means of a drum carrying two wheels, whose diameters are as two to one, which move two racks, which carry the carbons towards one another. This lamp is far too complicated and delicate in its mechanism to use with magneto-electric machines, and therefore the system adopted in it, for regulating the current and regulating the carbons, requires considerable modification, before this lamp can be adapted for general use for the purposes of electric lighting. It is especially adapted for use with optical apparatus, and for showing by projection on the screen the special characteristics of the arc formed by the glowing gases of various substances. We may use it now for showing the character of the arc formed by silver converted into a glowing gas by the intense heat of the arc. This arc shows us that silver is rich in the violet or chemical rays, and points to the reason why the salts of silver are of so much use in photography.

Electric Regulators or Governors.

By the laws of Ohm we get the relation between the electro-motive force, the current, and the resistance expressed by the statement—

The product of the current by the resistance in a circuit is equal to the electromotive force in that circuit, or $E = C(R + r)$.

Regulators may act so as to control—

1. The electromotive force and internal resistance of the battery or dynamo-electric machine.

2. Or they may control the useful resistance in the circuit.

3. Or they may control the external resistance, which does not produce useful work.

Regulators which control the current by altering the electro-motive force or internal resistance of the source of electricity, so as to counterbalance other distributing effects, are not practically of much importance, and so need not detain us long. Suppose, for instance, that an increase of current acted on a rotating governor in such a way as to raise the plates out of the battery, thereby increasing the internal resistance, this would diminish the currents which would so re-act on the governor, and again lower the plates. Or suppose the current passes round a coil which is set with its axis vertical, and that an iron rod supports the carbon and zinc in a bichromate of potash battery, and passes into the axis of the coil, then, as the current increases, the coil draws up the iron core and the battery plates, and increases the internal resistance, which diminishes the current.

Regulators which act on the useful resistance in

the circuit, *i.e.*, in the case of electric lighting, the different arrangements made in electric lamps for producing steady currents between the carbon points, by keeping them the same distance apart, are very numerous, and I hope to treat of them in a future lecture.

Another kind of regulator controls the current by varying the external resistance of the circuit, so that when the current increases an additional resistance is thrown into the circuit, and when the current diminishes the external resistance is diminished. If a machine is working with the greatest efficiency, then the addition of external resistance will diminish that efficiency, so that a regulator which varies the external resistance diminishes the efficiency of the machine in order to maintain a steady current.

There are many ways of varying the external resistance of a circuit; for instance, a rheostat set in action by clockwork, which is started by an armature of an electro-magnet placed in the circuit. If, for instance, as the current is weakened, the armature of the electro-magnet falls and releases a wheel of a clockwork arrangement, which diminishes the resistance by unwinding the wire of the rheostat. The methods which have been employed have been gradually simplified, and it is found that the simplest means are at the same time the most efficient. For weak currents, Edison's system, whereby a greater or less pressure on powdered carbon increases or diminishes its conductivity, has been employed. Edison also devised a regulator or shunt for the current, by the expanding of a platinum spiral wire placed in the lamp which short-circuited the current on reaching a certain definite temperature. Suppose, for instance, that an arrangement is made by which, when a current increases, part of it is sent through an electro-magnet, which draws up an arm so as to break the direct circuit, and send all the current through the electro-magnet, the resistance of the coil of the electro-magnet reduces the current, the arm falls, and again the current passes through the direct circuit.

Lane-Fox Regulator.

The regulator is an electro-magnet of very high resistance, which takes a branch of the current and acts on one end of a lever. The other end of the lever makes contact with one or other of two pins, which are connected with one or other of two coils forming electro-magnets, called respectively H and K, which govern either the throttle valve of the steam engine, or which may be made to introduce extra resistance by sliding contact over the wires of a rheostat. When the lever touches one of the pins, a current passes through the lever to the electro-magnet H and turns the arm in one direction, and when it touches the other pin, the arm turns in the opposite direction, so that in one case the resistance of the circuit is increased and in the other it is diminished.

Siemens Regulator.

By means of the expansion of a fine strip of mild steel or fused iron stretched between two points, when the electric current passes through it, a vertical spindle, supporting a circular metallic disc, with platinum contacts on its upper surface, is lowered, so that the contacts of platinum, with certain points in a helical rheostat, are broken one by one, and at each break an additional portion of the rheostat is thrown into the circuit, and so the excess of current is checked. For the normal current the rheostat is out of circuit, but an excess of current heats the wire, lowers the platinum contacts, and brings more or less of the rheostat into the circuit. For small variations of current, the change of current is nearly proportional to the change of temperature in the strip.

Methods of Measuring Electric Currents.

There are four principal methods of measuring powerful electric currents.

1. *The Galvanometer Method.*—With a tangent galvanometer of small resistance, it is necessary to bring the deflections to about 45° by a shunt of very small resistance, which sends only a very small part of the current through the galvanometer. Here there is a liability to error in the measurement of the resistance of the shunt. The objection to this method is, that a small quantity is measured by the galvanometer, and the error of the observation is multiplied, it may be a thousandfold, or even very much more, in order to arrive at any idea at all of the total current flowing in the principal circuit. I can only compare the method to an attempt to estimate the flight of starlings, or of a covey of birds, by measuring or marking, as accurately as possible, the flight of one particular bird which has been separated from the rest, and which is assumed to travel at the same rate, no matter what obstructions or attractive influences may have come across its path. At the same time, the difficulties of these measurements are so great that any method may be of great service, and this method has been employed by several observers with good results.

For strong currents, instead of a tangent galvanometer, Professor Trowbridge, of Harvard University, employs a galvanometer in which the coil carrying the current is capable of turning about a horizontal axis, passing through the centre of the needle. When the coil is vertical, the instrument is a tangent galvanometer; but on turning the coil through any angle, the part of the current which deflects the needle will be diminished: by this the current has very little effect in turning the needle when the coil is near the horizontal position.

2. *The Electrometer Method.*—The difference of potential between two points in a closed circuit may be measured directly, either by an electrometer like Thomson's quadrant electrometer, or by balancing the electromotive force between the two points, by a battery of the same electromotive force, in the circuits of which a galvanometer is placed, in which case the electro-motive force is found by finding at what points the wires from the battery shall be attached, so that no current shall pass through the galvanometer. An instrument for the purpose I have described is Clark's potentiometer. This method has been employed by Dr. Hopkinson, and by others, to determine the current produced by a Siemens machine for the electric light. It has also been applied by Mr. Joubert and others to determine the current required to make the Jablochkoff candle burn at its best, and also for the estimation of the current given both by continuous current machines and also by alternate current machines for producing the electric arc.

3. *Method of using Thomson's Electrometer.*—If V be the potential of the needle, and V_1 V_2 the potential of the quadrants and d the deviation of the needle, k being a constant, then

$$d = k\,(V_1 - V_2)\left(V - \frac{V_1 + V_2}{2}\right)$$

But, if the needle and one pair of quadrants be connected,

$$d = \frac{k}{2}\,(V_1 - V_2)^2, \text{ where } V = V_1$$

so that the deviation is proportional to the square of the difference of potential, and is therefore independent of the direction of the current.

By means of two electrometers so arranged, the current and the energy expended between any two points of a circuit may be at once determined. First consider the case of a continuous current. Let one electrometer have its poles attached to two points A and B of the circuit where the potentials are V_1 and V_2, having a resistance r_1 between them and a current C, then

$$Cr_1 = V_1 - V_2.$$

Now take two other points, C and D, in the same circuit, which have a difference of potential $V_3 - V_4$, and which have an electromotive force, E, as well as a resistance r_2 between them, then

$$E + Cr_2 = V_3 - V_4.$$

Then the energy expended between these two points is

$$C\,(E + Cr_2) = \frac{(V_1 - V_2)\,(V_3 - V_4)}{r_1},$$

so that the deflection of the two electrometers will at once give the

$$\text{Energy expended} = \frac{2}{r_1}\sqrt{\frac{d_1 d_2}{k_1 k_2}}.$$

One electrometer gives the current, and the two together give the work expended.

If instead of a continuous current, we have alternate currents succeeding one another at intervals which are very short compared with the time of oscillation of the needle, then the needle will remain steadily deflected at a deviation proportional to the mean value of the square of the difference of potential—

$$d = \frac{k}{2}\,(V_1 - V_2)^2.$$

In this case the differences of potential must be measured absolutely at the same instant. This may be done by placing two contact breakers on the revolving axis of the dynamo machine, so arranged that by both of them contact is made and broken at the same instant some 20,000 times in a second, then the two electrometers will give the desired results. In place of the electrometer which is employed to give the strength of current, a galvanometer may be employed, as in Clark's potentiometer, in which case, it is only necessary to have one contact breaker, and so the arrangements are more easily made.

The law of variation of the current in alternate current machines may be obtained by the law of variation of the resistance for different periods of contact, *i.e.*, for different phases of rotation of the contact breaker. Thus the different phases of the current may be studied by dividing the period into a certain number of equal parts, and, by means of the contact breaker, making contact only at the same phase of the period of revolution.

The intensity of the light at the different phases of the period may also be studied and measured by means of revolving discs with holes in them, arranged so as to let light through only at the proper instant. The result of experiments is that the law of increase of current in alternate current machines is the law of simple harmonic motion, but the maximum effect does not occur at the normal position, but is displaced in the direction of the motion. Experiments, of which a full account has been given in *La Lumière Electrique*, have shown that even with coils alone there is a retardation of the inductive action arising from the induction of a current on itself. The retardation is about ⅛th of the whole period, even with a bobbin without a soft iron core, and this displacement is independent of the velocity, and rigorously the same for 400, 700, or 1,000 turns in a minute. In the case of magneto-electric machines, there is a retardation which is usually attributed to the retardation of magnetisation of the magnet, but that does not apply to the case of coils, in which case the retardation depends on the self-induction of the current. By the above method, the fall of potential between the carbons in the arc may be measured at different phases of the period of revolution. Thus it is found that at the instant when the circuit is made there is no difference of potential, but in an indefinitely short time the electromotive force rises to 40 or 45 volts, and remains at that value almost without change until the current again becomes very feeble, and then the electromotive force suddenly falls. The difference of potential in the arc seems to be constant within very wide limits for the values of the current. The conclusions arrived at by M. Joubert are that the resistance of the arc is very small; that it varies with temperature and diminishes as the temperature increases. The difference of potential between the two carbons is due to an electromotive force, which is independent of the current, and which is estimated by him at 30 volts. Particles pass between the carbons just as between the electrodes in a voltameter. There seems to be an action like polarisation, and the work done depends only upon, and is proportional to, the quantity of electricity which passes.

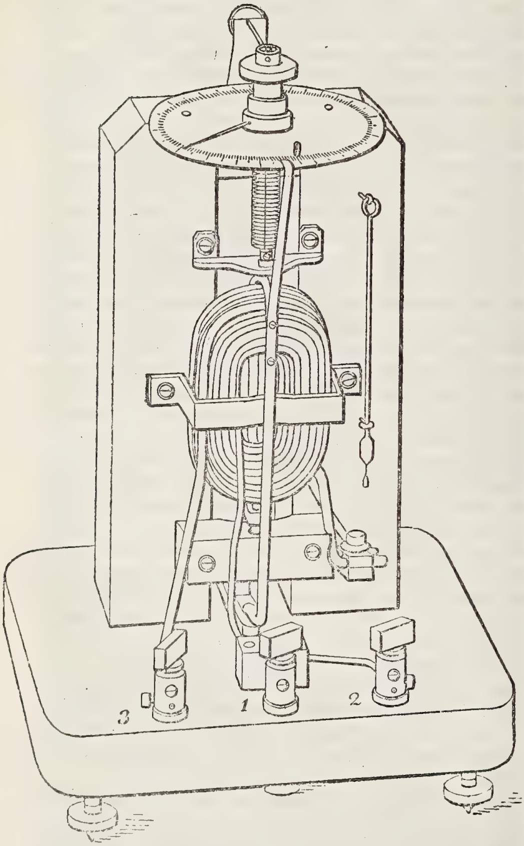
Another method of measuring the currents which is applicable to both continuous currents, and to obtain the average values of alternate currents, depends on the development of heat in an electric circuit. It was shown by Joule, and follows from the law of transformation of energy, that the heat developed by a current C in a resistance r in time t is $C^2\,r\,t$, hence the current C may be measured by the quantity of heat received in a given time by water, in which a resistance r is immersed. This method has been employed by Dr. Siemens, and was one of the methods employed by Dr. Hopkinson in measuring electric light currents.

In his experiments, Joule inserted a wire of known resistance in a given quantity of water placed in a calorimeter, and measured the change of temperature of the water, and also measured the current, and found that $H = C^2\,r\,t$ where H is the quantity of heat produced by the current.

The Electro-Dynamometer Method.—There is still another method of measuring currents, which Maxwell says, "is probably the best fitted for absolute measurements."

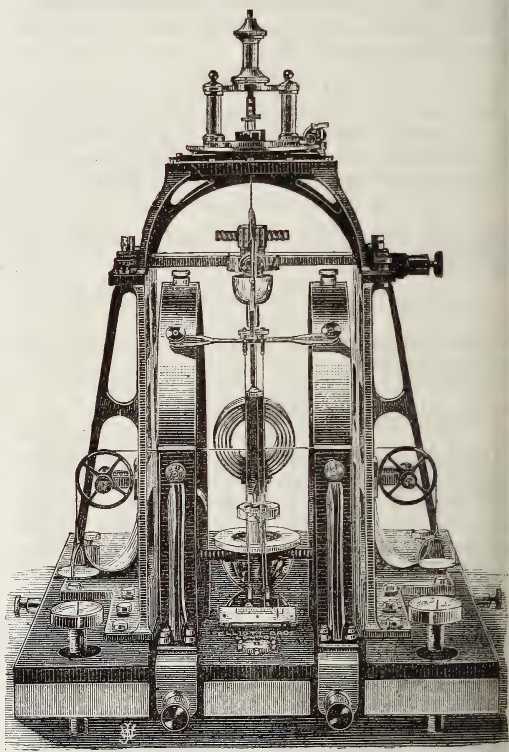
In Weber's electro-dynamometer, one coil is suspended within another, by means of two fine wires, through which the current is led to the suspended coil. This arrangement is not suitable for powerful currents, because shunts become necessary, and because the suspended wires become heated.

An electro-dynamometer on the same principle has been devised by Dr. C. W. Siemens, who has kindly lent me one of his instruments for these lectures.



Siemens's Electro-dynamometer.

Attached to a binding screw (3) is one end of a fixed coil or bobbin, across which a single turn of copper wire with its ends dipping into two mercury cups, is freely suspended in a vertical plane, so as to turn about a vertical axis. One of the mercury cups is electrically connected with the binding screw (1) and the other with one end of the fixed coil, so that between 1 and 3 the same current passes through the fixed coil and suspended wire. When the current passes, the suspended wire tends to turn about a vertical axis, but its motion is counteracted by a torsion spring, to one end of which the wire is attached, the other end being fixed to a socket carrying an index, which must be moved over a graduated circle, so as to bring the suspended wire back to its initial position. The action between the currents in the coils, and therefore the torsion which measures it, is proportional to the square of the current. By increasing the number of turns in the fixed coil, and having only one turn in the suspended wire, the action of the earth's magnetism on the current in the suspended wire may be neglected in comparison with the action of the fixed coil upon it, so that the position of the plane of the magnetic meridian at the place of observation may be disregarded in using this instrument. There are usually two fixed coils or bobbins; one coil, attached to binding screw (3), being of a small number of turns of thick wire for continuous currents, and the other, attached to binding screw (2), being much longer and finer, for use with machines giving alternate currents or currents of high tension.



Hill's Electro-dynamometer.

An electro-dynamometer has also been devised by Professor Trowbridge, of Harvard University, in which there are two large fixed coils made from copper bands, between which is suspended from a torsion head a small coil with mercury connections, so that all the current passes through each coil. This instrument has been improved by Mr. W. N. Hill, who limits the swing of the central coil, and measures the current by bringing the coil back to its zero position, by balancing the force of repulsion of the coils by weights placed in two scale pans, one on each side of the instrument, so as to balance the action of the current by torsion of the suspending wire. If c be the current, $w\,l$ the twisting

moment of the weight w, G, and g the constants for the two coils, and k the constant of the instrument,

Then $C^2 = \frac{l\,w}{k\,G\,g}$

G and g are found by measurement, and k is found by comparison with another instrument. Through the kindness of Messrs. Elliott Brothers, I have the opportunity of bringing before you an electro-dynamometer of this form with the latest improvements. This form of dynamometer is especially applicable for large currents, since the weights required to bring the deflection to zero increase as the square of the current, and so greater accuracy may be attained.

[The two blocks illustrating this lecture have been kindly lent, that of Siemens's electro-dynamometer by the Director of *La Lumière Electrique*, that of Hill's by the editor of the *Electrician*.]

MISCELLANEOUS.

POST-OFFICE REPORT.

The twenty-seventh annual report of the Postmaster-General has just been issued, from which the following particulars have been taken :—

LETTERS.

The number of letters delivered in the United Kingdom during the 12 months was 1,176,423,500, showing an increase of 4·3 per cent.; the number of post-cards, 122,884,000, an increase of 7·4 per cent.; the number of book packets and circulars, 248,881,600, an increase of 16·3 per cent.; and the number of newspapers, 133,796,100, an increase of 2·5 per cent. There is again a marked increase in registered letters, the number recorded being 10,034,546 against 8,739,191 of the previous year, or an increase of 14·8 per cent.

The machinery of the department has necessarily been extended; 337 new sub-offices have been opened, raising the total number of such establishments to 13,637, which with 912 head offices, makes the grand total of post-offices 14,549. About 620 letter-boxes have been added, and the number of receptacles of all sorts for letters may be stated at 27,709.

Eight hundred officers have been added to the force, which, on the 31st of December last, had reached a total, including all grades, of over 47,000 persons, of whom over 2,000 are women. The success obtained in employing women as clerks in the Savings-bank and the Receiver and Accountant-General's Office has led to their number being considerably increased. Hitherto these clerks have been appointed upon a plan of limited competition, three being nominated to compete for each vacancy. In future, however, the appointments will be made through open competition, subject to rules issued by the Civil Service Commissioners. Another important extension of the principle of open competition has been carried out, male and female telegraphists in London, Edinburgh, and Dublin being now appointed in this way. The health of the 10,900 officers employed in London has been generally good; the death-rate, uniformly low, has fallen to a point below any previously recorded, the actual number of deaths in London being 45, and the rate per 1,000—4·1.

Among the incidents of the year may be mentioned snow storms of extraordinary violence, which, impeding railway communication, and severely taxing the energies of the department, occasioned large additional expenditure. On the 18th of January no night mail could be despatched from London, and on Friday, the 4th of March, five carriages were blocked in the snow in Scotland, and were not extricated till the following Monday, while the Sutherland and Caithness Railway was completely closed for a fortnight. However, during the whole period of the storm not a single mail bag was lost, nor, throughout the year, did any accident occur involving the loss of a life engaged in the postal service. A letter containing a £1,000 cheque, which should have been posted in Lombard-street on the 18th of January, was found on the 24th in the Thames near Deptford, among some snow drift which had evidently been carted from the City and thrown into the river. The letter, which had never passed through the Post-office, was duly returned to the sender. During the Christmas week more than 11½ millions of letters and packets, over and above the ordinary correspondence, and four tons of extra registered letters, representing a total postage of nearly £58,000, passed through the central office. To meet such extraordinary pressure the services of volunteers from other departments of State were obtained after office hours, and the assistance thus procured was found most valuable.

Over 5,300,000 letters were dealt with in the Returned Letter Office, 475,000 of which it was found impossible to deliver or return. One contained a bank-note for £100, still unclaimed; and attached to the seal of another was a sovereign, which was returned to the owner, who had forgotten to remove it. In addition to the letters, about half a million of post-cards, four million of book packets, and 400,000 newspapers found their way to the same office. More than 27,000 letters, an increase of 3,000 over last year, were posted without any address whatever, 5,000 furnished no clue to the sender, and 1,340 contained articles of value to the amount of nearly £5,000. The use of too fragile covers occasioned the escape of some 30,000 articles, and, no doubt, entailed much disappointment. The habit of transmitting animal and perishable matter, such as fish, sausages, birds to be stuffed, clotted cream, fruit, yeast, salads, jellies, live kittens, and dead rats still prevails; and it is necessary to appeal to the public to discontinue a practice so injurious to the health of the officers in one branch of the department, and to repeat the warning that such forbidden articles will be stopped. The return of a letter, posted without an address, to a firm whose direction appeared within, led to the discovery of a systematic robbery of goods and the apprehension of the offenders. At Hull, an incident occurred proving the elasticicity of the postal organisation under heavy pressure. The distribution of nearly 300,000 circulars, weighing 20 tons, issued by a single company, and representing £2,380 worth of postage, was effected without confusion or delay in 48 hours. The despatch necessitated the employment of seven extra railway vans, and it is believed that all the documents duly reached their destination.

PARCEL POST.

In October last a Postal Conference, attended by the Secretary of the Department, and Mr. Benthall, one of the Assistant Secretaries, was held in Paris to consider the possibility of establishing an International Parcel Post. After much discussion, an agreement was arrived at providing for the transmission throughout almost the whole of Europe of parcels not exceeding three kilogrammes (about 6½lb.) in weight at very moderate charges. It was, however, impossible for Great Britain to sign the treaty which embodied these conclusions without having previously established for herself an inland parcel post.

TELEGRAPHS.

The telegraph business of the United Kingdom continues to increase; the messages sent were more numerous by 3,419,828 than in the previous year, and the aggregate reached 29,966,965. During the year 107 new offices were opened, and the total number now stands at 5,438. The new main line from London to

towns in the north of England and to Scotland, commenced in 1880, and now complete, forms an important addition to the system, and the wants of the metropolis and its neighbourhood are being met by a considerable multiplication of wires. The snow-storms in January occasioned many breakages and much labour. Messages sent by persons unable to reach their homes added to the pressure on the department, and on 19th of January the Central office alone dealt with some 6,800 messages above the average number.

Telephones.

On the 20th of December, an important decision of the Exchequer Division of the High Court of Justice defining the rights of the department in connexion with telephones was given against the companies which had established exchanges, but after much negotiation an agreement was concluded which, while protecting the interests of the public, afforded reasonable advantages to the companies concerned. The system of telephonic intercommunication is, therefore, now being extended partly through the agency of companies and partly by the Post-office. The Department has in course of completion telephone intercommunication systems at Swansea, Glasgow, Greenock, Hull, Manchester to Liverpool, Newport to Cardiff, Leicester, Sunderland, and other towns, and is receiving applications from many quarters.

Savings Banks.

Much has been done during the year to encourage thrift. On the 22nd of November, 1880, an Act came into operation by which any person desiring to invest any sum between £10 and £100 in Government Stock can do so through the agency of a savings bank at a trifling expense, varying from 9d. to 2s. 3d., and have the dividends collected free of further charge. The purchase can be effected either by transferring money from the depositor's account, or by means of a sum specially deposited for immediate investment. Between the 22nd of November and the 31st of March the amount thus transferred through the Post-office Savings Banks was £151,465, and the amount specially deposited. £230,674, making an aggregate of £382,139 invested by about 6,300 persons, and it is satisfactory to notice that the sales did not exceed £7,500. The stock certificates with coupons payable to bearer, obtained under Section 3 of the Act, were, in the period stated, 63 in number, and £4,950 in amount. Notwithstanding the channel thus opened, the total amount of deposits, with the interest due, had, on the 31st of December, reached £33,744,637, showing an increase of £1,732,503 over the amount recorded on the corresponding day of 1879. The Post-office Savings Bank year, prescribed by statute, terminates on the 31st of December, but comparing the financial years ended 31st March, the result obtained is:—The total amount of deposits on the 31st of March, 1880, including interest to previous 31st of December, £32,578,405; the total amount of deposits on the 31st of March, 1881, including interest to previous 31st of December, £34,782,329; estimated increase in the financial year ended the 31st of March, 1881, £2,203,924.

The attention of the department had for some time been drawn to the demand for a minimum limit of deposit lower than the shilling prescribed by Parliament. With a view to meet this demand, and to encourage the saving of very small sums, the Postmaster-General adopted a plan which was submitted to him by Mr. Chetwynd, the Receiver and Accountant-General. Small slips of paper, specially prepared, were provided by the department, and distributed gratis, with an intimation that, if 12 penny postage stamps were affixed to them, they would be accepted as a deposit of one shilling. The plan was, in the first instance, tried as an experiment in certain counties in September last. Before it had been in operation for more than a few weeks, its success became so marked that the Postmaster-General decided that on the 15th November it should be extended to the whole country. The cleanly condition in which the slips arrive is worthy of notice. The number received to the close of March was 576,560, and it is estimated that 223,000 new accounts originated in this manner.

The number of Post-office Savings Banks now open in the United Kingdom is 6,302, as against 6,016 mentioned in the last report.

The condition of the Savings Banks in Ireland is still a subject of peculiar interest. The increase of capital recorded in the previous year has not only been maintained, but has been augmented by £47,000, and is larger than any annual increase during the past ten years. The total amount, including interest, due to depositors on the 31st of December last was £1,555,900, being £138,500 in excess of the total of the previous year, exclusive of a sum of £17,000 invested in Government Stock. The names of about 10,000 new depositors were added, and the proportion to population is 1 in 65, as compared with 1 in 74 in 1879. Every county in Ireland contributed its quota, and the increase in the eight counties scheduled as distressed amounted to £8,448 over and above the growth of the previous year —viz., £33,866 against £25,418.

Postal Orders.

Under the provisions of the "Postal Orders Act, 1880," a new system was introduced on the 1st of January, providing an inexpensive and easy way of sending small sums of money to different parts of the United Kingdom. This Act was founded on a Bill introduced in the previous Session by Lord John Manners. Drafts, entitled postal orders, can now be bought, at any money-order office, for different amounts, varying from 1s. to 20s., subject to a commission ranging from one halfpenny to twopence. In three months, 646,989 of such orders were sold of the value of £292,150, producing commission to the amount of £3,750; and it is evident, from the increasing demand, that the public appreciate the convenience thus provided. The decrease in the number of money-order transactions, which commenced in 1878, is again visible. The inland orders recorded show a falling off of 2·7 per cent. in number, and 2·2 per cent. in amount as compared with the previous year. This result is no doubt attributable to the increased facilities of transmission by other means, such as registered letters and postal orders. The number of orders for large amounts increase, and the foreign and colonial business exhibits a steady progress. Notwithstanding the diminution in the number of inland orders, the gross amount transmitted for the public was over 26 millions sterling, and the losses by fraud and default did not exceed £215. It will be seen that the decrease in the gross amount, as compared with last year, is nearly made up by the amount of postal orders issued in three months, and it may be expected that the results of both methods combined will eventually produce a total considerably in excess of the amount formerly transmitted by money orders alone.

Revenue.

The gross revenue collected within the year was a little over 8¼ millions, that is, £8,367,311. The expenditure was, £5,440,665. The net revenue was, therefore, £2,926,646, being an increase of £88,017 on the previous year.

The capital sum raised for the purchase of the telegraphs since 1869 exceeded 10 millions sterling, and hitherto the results of the undertaking have exhibited an annual deficiency of interest amounting in the aggregate to not less than £1,216,000. For the first time, however, the net telegraph revenue for the year—viz., £328,878, has been sufficient to pay the full

interest, 3 per cent. on the capital, and leave a real surplus of £2,462 towards the cancelling of debt.

It is to be observed that, in consequence of the Savings Bank funds being vested in the National Debt Commissioners, no allusion is made in the accounts to the revenue and expenditure of the Savings Bank Department, but the Postmaster-General adds the following particulars:—The expense of conducting savings bank business during the year was £180,891, or £3,389 less than in the previous year. This apparent decrease of expenditure at a time when there was a large increase of business was, in a great measure, due to the fact that the proportion of the cost of the new savings bank building in Queen Victoria-street charged to the year 1880 was much less than that charged to the previous year. The net profit paid over to the Exchequer by the National Debt Commissioners was £144,879. It would, therefore, appear that the real Post-office expenditure was £5,629,556, and the revenue was £8,701,081, showing a profit of £3,071,525.

THE GOLD MINES OF SOUTH INDIA.

The following is an abstract of a report on this subject by Mr. Mervyn Smyth, which was printed at Bangalore, in March of the present year:—

Mr. Brough Smyth, speaking of the extent of the Gold producing region in the Wynaad, says:—"Gold has been found in the South, near Eddacurra; on the North, near Nellacottah; on the West, near Vyteri; and on the East, as far as Bolingbroke, that is to say over an area of more than 500 square miles." (Report on Gold Mines, p. 61.) Of this area, native workings have been confined to Devalla and its vicinity, a mere fraction of the country indicated; and even here the mines are of no magnitude, the deepest shaft being 70 feet, and the longest adit 126 feet; and yet it is from such workings as these, within those narrow limits, we are asked to believe that such enormous quantities of gold as the following, were obtained:—"B.C. 1000. Gold brought to Solomon by way of the Red Sea—3,330,000 lbs. weight. A.D. 1294. Ransom paid to Alau'a din, General of Jalalu'a din Khilgy, Emperor of Delhi, by the Raja of Deoghar—17,500 lbs. of gold. A.D. 1310. Part of spoil of Devara Samudra (Halabid, Mysore) presented by Malik Kafur, to the Emperor of Delhi—2,400,000 lbs. of gold. A.D. 1309. Accumulations of Kales Dewar, Rajah of Mabar—1,200 crores of gold, equal to 1,200 millions sterling or 90,800,000 lbs. of gold."—(Gold in India.) That India may have produced this enormous quantity of gold is not improbable, as witness the yield of the Australian mines from 1851-68, viz., 147,342,767 pounds sterling; but what we may well doubt is that all this wealth could have been derived from the Wynaad. Another point which strikes one, and which goes to prove that the Wynaad could not have been the locality from which all this gold was obtained, is the singular absence of ruins of cities, temples, &c., and the presence of primeval forests of vast extent. One would imagine that where such immense wealth came from, *there* would be indications of its influence, in the shape of great cities, vast temples, tanks, cultivation, and other signs of civilisation, be most common, and that such would be the natural result of unprecedented wealth we see exemplified in the rapid growth of those marvellous cities—St. Francisco and Melbourne—that have sprung up in a wilderness far more desolate than the Wynaad. The question that suggests itself is, if we are not to look to the Wynaad as the spot from whence this large quantity of gold was derived, where else are we to look? It is thought that all the necessary requirements are satisfied in an examination of the country forming a great triangle, whose sides may be indicated by the Eastern Ghauts, the River Kistna, and the Western Ghauts; and this country was known as Mysore at the death of Hyder Ali in A.D. 1782—a region whose geological aspect is similar to that of the gold-bearing regions of America and Australia. Mr. Eastwick, in an article in the "Gentleman's Magazine" for January, 1880, mentions as one of the facts illustrative of the abundance of gold in Southern India, part of the spoil of Dwarasamudra, amounting to 2,400,000 lbs., presented to the Emperor of Delhi, by Kafur, his successful general. The ruins of this city are to be seen in the vicinity of Halebid, in the Hassan district, Mysore. It is said to have been destroyed shortly after its capture by Kafur by another of the ruthless Mahomedan invaders. The splendid temples still in existence speak of the great wealth of this place. Of the wealth derived from India by Solomon it will be sufficient to say that many of the incidents recounted in the Ramayana, B.C. 1300, show that Mysore was at that time in a flourishing state. Among great cities of more recent date may be mentioned Ikkeri, Shemoga district (A.D. 1640), where gold pagodas and fanams were coined, many of which are still to be seen in the Mysore country, Bednur, or Nagur, at the capture of which place Hyder was said to have obtained twelve millions sterling. Here he established a mint where gold coins—Haidari pagodas—were struck in his name. Vijayanagar (A.D. 1565) identified with Hampe in the Bellary district. Abdul Razzak, who visited it in 1441 as ambassador from the court of Persia, speaking of its wealth, says—"In the king's treasury are chambers with excavations in them filled with molten gold, forming one mass. All the inhabitants of the country, whether high or low, even down to the artificers in the bazaar, wear jewels and gilt ornaments in their ears and around their necks, arms, waists, and fingers." It will be presently shown that all these cities were situated in or near districts known to be auriferous in the present day, and where may be seen ruins of mines of great extent. Of the N. and S. Ponaar (*Pon*—gold, *aar*—river) it will be sufficient to mention the villages of Nulloor and Coondoor, on the former, and Utchalam and Poonpillay, in the Salem district, on the latter, where gold-washing is carried on to the present day. On the western coast gold is found in the Gungavelly and Gairsoppa rivers, N. Canara, and in the Beypore river, in Malabar. The auriferous reefs and old workings of the Wynaad have been reported on by Mr. Brough Smith, while those of Kolar have had more than justice done them by such men as Mr. Munday, Mr. John Harris, Professor Vazie Simon, &c., who have examined them on behalf of different companies. But it is not to these localities alone that auriferous reefs are confined, but scattered all over the whole area are gold-bearing reefs and old mines, some of the latter of far greater extent than any to be found in the Wynaad or Kolar, and it is believed that no spot within the boundaries mentioned can be indicated, which is more than 50 miles from the nearest ancient working. Immediately south of Kolar is Baramahal, in the Madras Presidency, wrested from Tippoo in 1792. The greater portion of this district is made up of low hills, from 1,500 ft. to 4,000 ft. high. In the northern part of this district are the Jaghires of Bagalur, Beriki, Sholagherry, and Kangundi, the mining rights of which have been purchased by several companies. About ten miles west of the Coopum Railway Station is a singular looking conical hill, rising about 600 ft. above the surrounding country, and about 200 ft. above the remainder of the ridge, which runs north and south, for about 15 miles. The top of this peak terminates in a boss, which overhangs on its S.W. side and gives it a conspicuous appearance, so that it can be recognised from miles off. This hill is known as Mallapakondah, and is situated in the Kangundi Jaghire, Salem district. Half-way up this hill, and on its southern face, is the entrance of an adit driven into the heart of the hill. It would appear that there were originally several of these drives at different levels, and the topmost is now filled in with

the sinking of the roof, which can be traced for a hundred yards or so on the surface of the hill. The lower levels are still open, but obstructed here and there with great blocks of quartz and casing, but with a little trouble and some inconvenience from the crowd of bats that come trooping out at this unusual intrusion, one can penetrate about 50 yards. Of course a lighted candle is necessary, as all is darkness within. The mine is called by the natives "Gowd-shanie," and the inhabitants of the village of Purtheguttay, near the foot of the hill, are quite willing to lead the traveller to the mine, but they know nothing of its construction, or that gold can be obtained from it. A well-made road about 4 ft. wide, and paved the whole way ($1\frac{1}{2}$ miles) with large stones, leads to the mouth of the mine, and testifies to its wealth, as it must have paid well to have allowed of so expensive a pathway being constructed. The quartz is highly ferruginous and dark coloured, dense in centre and cavernous where it joins the casing —the latter a kind of vitrified slate. The principal reef is about 10 ft. wide, and on either side are smaller reefs, from 2 ft. to 2 in. Sulphate of iron is apparent in some of these, and it is not difficult to collect flowers of sulphur in small quantities. No gold can be seen in the quartz by means of the naked eye, but a small piece of a few ounces, crushed and washed, gives innumerable grains of fine gold. It is not necessary to choose a particular piece of quartz; any bit from the *débris* lying about may be tested with good results. Two miles south, and on the same ridge, are two other mines within half a mile of each other. The more northern, called "Goolgunta," consists of three circular shafts sunk at the angles of a triangle, whose side is 50 ft. The shafts are connected by passages at about 40 ft. from surface, but it is impossible to tell their extreme depth, owing to the large quantities of water in them. Great heaps of *débris* testify to the amount of material that must have been excavated. Half a mile S.E. is the "Chigarulgunta" mine, the entrance to which is by means of two shafts, each about 7 ft. wide and 20 ft. long. The upper shaft is about 60 ft. deep, and at one end is a narrow manhole (just large enough for a small man to wriggle through), leading into the adjoining shaft, which is fully a 100 ft. from surface. At the bottom of the deeper shaft are two adits, running N.W. and S.E. along the strike of the reef. Great numbers of rock pigeon have taken up their abode in these mines, and eggs innumerable and young pigeons are seen in the clefts of the rock. The great heap of excreta of these birds (not less than 20 ft. in height) testify to the age of these mines. The whole of the rocks below are coated with chloride of ammonia (sal ammoniac) from the urine of the pigeons. The quartz is of a yellowish white colour, and pyritous, and is extremely hard, as is the casing, and it is wonderful to think how the natives could have cut through such dense stuff with their primitive appliances. One sample containing visible gold was chipped off from a leader 100 ft. from surface. Two miles further south is another large mine called "Nundymoduk" or "Baswana." The natives say that this mine is of great extent, but the water with which it is nearly filled prevented its examination. The natives have a tradition that when the miners from seven adjacent villages were engaged picking away the quartz at the bottom of the mine, the water from the neighbouring river (S. Ponaar) found its way into the mine and drowned the workers, since which period it has been abandoned. There appears to be some truth in this statement, as when this mine was pumped dry, some three years ago, the skeletons of several human beings were found. This, and the two last-mentioned mines are in the Beriki Jaghire. Numerous other mines exist in this and the adjoining jaghires of Sholagherry and Bagalur, and the whole country is cut up with numerous quartz reefs, and gold is washed in all the streams during the monsoon. The whole of this country bears marks of advanced civilisation at an earl date. At present it is a wilderness of thorny shrub with here and there small villages of from 40 to 50 house In the immediate vicinity of the mines just mentione are the ruins of two large cities—Nungungowdah an Dauerkondanee. The ruins of the former cover severa square miles, and the breached bund of an immens tank, 50 ft. high, and 1 mile long, and pitched through out with large stones, testifies to its importance. I Dauerkondanee are still standing several temples, buil throughout of finely chiselled stone, in good preserva tion. The elaborate and delicate carving of the cornice the great size of the blocks used, speak of the lavish us of money. Numerous inscriptions in ancient Kannad line the basement of the inner temple. On the adjoinin hill ("Yale Kotay mulla"-seven fort hill) the remain of fortifications are to be seen, one above the other t the top of the hill. Within the topmost line of fortifica tion is a large cave running some distance into the hear of the hill; and within this cave, tradition has it, th mint of Ballala Raj was constructed. To this day, they say, when after heavy rain, water rushes from th mouth of the cave, small gold coins are occasionall picked up. This locality, with its numerous antiquities affords ample materials for the archæologist. Eight miles south from this place, we come to the mine worked by Tippoo, in the Kolegal Taluq, Coimbator district. These mines, as well as those in the adjacent Taluq of Chamrajnuggar, Mysore Territory, were filled in, it is said, by Tippoo, and the inhabitants o the neighbouring villages deported, to prevent intelligence of these workings reaching the ears of the English, under Lord Cornwallis, who invaded Mysor from this direction. The mines in Chamrajnugga are of great extent and of much antiquity, and it is from this region that all the gold said to be so common at Munipur is supposed to have been got. Land for mining purposes in Chamrajnuggar and Kollegal has been applied for, by several English and Indian Companies. Thirty miles to the W.S.W. we come to the Neilgherries, where there are old workings of some extent at Nunjanaud, described by Mr. Brough Smyth in his report on the Wynaad. Further west we have the gold fields of the Wynaad and Malabar. Skirting North Wynaad is the Heggadevenkota Taluq, Mysore Territory, where gold is said to be found in the streams. ("Mysore Gazetteer," Vol. II. p. 193.) Still further north, in the Attikuppa Taluq, we have the gold field of Chinnataghery, near Belli-betta. These mines are reputed to have been of great wealth, but to have been worked out. The famous temple of Melukote —the richest in Mysore—is said to have been built with the wealth derived from these mines, but at present a few washers are just able to earn a precarious livelihood by sifting the sands of the neighbouring streams, during the monsoon. The late Maharajah of Mysore made an attempt to work these fields, and employed a set of native miners for about a month, but as no results were obtained, the attempt was abandoned. About twelve years ago several samples were sent in from this locality by Col. Hill, of the Mysore Commission, with a request that they might be assayed, and something be done to open these mines, of which about 54 exist at Belli-betta, if the result of the assay should be favourable, but nothing seems to have been done, the report was pigeon-holed, and the samples sent to the local museum. At present the land has been applied for by several European gentlemen, and the truth of the report of the exhaustion of its auriferous product will soon be tested. North again, we come to the ruins of the once famous city Dwarasamadra, now called Halebid (*Hale*, old, *bedu*, houses). Allusion has already been made to the great wealth of this city, in comparatively modern times; no less than 2,400,000 lbs. weight of gold was paid to Kafur as a ransom, and it has often been a subject of inquiry as to where this vast quantity of the precious metal could have been obtained. An

examination of the low slate hills to the west of Halebid, and so far north as Sakarapatam will show, that they are in some places actually honey-combed with mines, some in good preservation, others filled in with *débris*. Every stream about these hills gives a small yield of gold, showing that their auriferous wealth is far from exhausted. In the adjoining Taluq of Harnhalli, are numerous mines and old workings, and so common was this metal during the reign of the Hoysala Ballala kings, that a local tradition has it that the sculptors employed on the famous Halebid temple, were paid in gold equal in quantity to the dust resulting from the tooling of those "marvellous elaborations of ornamental sculpture." There may be some truth in this tradition, as even the price alleged to be paid to the masons would not be too much for work that has called forth the following eulogium:—"Some of these are carved (on stone) with a minute elaboration of detail which can only be reproduced by photography, and may probably be considered as one of the most marvellous exhibitioas of human labour to be found, even in the patient East." ("Fergusson's Architecture," p. 397.) These temples are computed to have cost nine millions sterling. Seventy miles due west from Halebid, and in the South Kanara District, we have the celebrated diggings of Moondabetta, seven miles south of Mudu Badari. Here, too, European enterprise has stepped in, and after one or two failures is now in a fair way of success. North-east from this we have the Honnali fields in the Shemoga District. Of the richness of these fields we may judge from the following official communication from Mr. W. Hill, Deputy Commissioner of the Shemoga District, to the Commissioner of the Nagar Division, dated respectively Novmber 16 and December 16, 1878:—"The only place in the district where gold is to be found is a Nulla near the village of Pulvanhulle in the Chattanhulle margin of the Honnali Taluq. It appears that gold dust was formerly obtained by washing the sand of the nulla. The right to do so used to be farmed out under the head 'Julgar,' but this item of revenue was abolished in 1870. *Vide* Isthiar, dated 28th September, 1860, the amount of contract realised was—1857-58, Rs. 357 8 a.; 1858-59, Rs. 264. Since then 2 to 4 Rs. weight is brought weekly to the market at Nyamti for sale by the julgars (sifters)." "Since writing my letter, No. 763, of the 16th ultimo, on the gold washed out from the sand, or rather alluvium, of the Palavanhulli stream, three miles south of Nyamti, I have the honour to report that I have been able to visit the spot and gather the following further particulars:—(2.) The number of men who gain a livelihood by washing the gold is about 20. Their number was formerly greater, but several have been attracted during the last ten years to a hill called Bijari Gudda, near Karkal in South Kanara, where the finds are said to be greater and the work more remunerative. Work is carried on in Pulvanhulli mostly in the rainy months, and regular workers are said to be able to earn as much as Rs. 50 in the season. Once and again small nuggets are met with. The largest found was about ten years ago, 1 oz. 14 dwts. 6 grs. in weight; another, more recently, of 1 oz. 5 dwts. 17 grs.; and a third, accidentally to an outsider, of 1 oz. 1 dwt. 10 grs. in weight. The quantity of gold bought annually in Nyamti and the neighbourhood is said by the traders to be 1 lb. 11 oz. in weight, of the value of Rs. 800. I beg to forward a small specimen of the gold, valued at Rs. 5 (to be obligingly returned if not bought for the museum), also some black ferruginous sand with minute particles of gold (of the value of As. 3), such as usually found by the washers. The process followed by them is very simple. They dig up the loose gravel (alluvium) in the bed and sides of the stream, and putting a quantity of it in a small trough, on a slight incline, wash the earth out about three or four times, and cast the heavy stones away, till only the light black sand remains. This they put into a hollow, flat, round, wooden dish, sift it, if the particles of gold are visible, after which they gather them together with the use of mercury, which, being volatile, is afterwards easily separated. The diggings are not confined to the Palvanhulli stream, but to all the minor streams flowing from the hills in the neighbourhood. One of the best is said to be the Surhona stream, near Devikopa, a little off the Kumsi Honali road, about three miles N.W. of Nyamti, and about the same distance from Palvanhulli. The chief drawback to its being worked is the want of water. The Jalagars (washers) informed me that they were well aware that gold was dug up from pits in Kanara, but they explained that it would be useless to attempt it here, as veins of gold were not found embedded in the quartz. I forward specimens of the quartz, slatey rock, gravel, and hematite (iron stone) picked up by me at the heads of the streams from which the gold is washed down. They may be of assistance in enabling Mr. Brough Smyth, with the foregoing information, to judge whether it would be worth while to take the trouble of inspecting the locality. Evidently the prospects of finding richer veins in South Kanara are greater." It is a noticeable fact in Indian polity, that where a handicraft has been confined to a family, or set of families, for a lengthened period, the people who practice the calling are identified with it, and it becomes a caste distinction, as much as the well-known four great divisions of Brahmin, Kchetria, Veishya, and Sudra. The goldsmith is as much distinguished from the weaver as the Veishya from the Sudra, while the barber and shoemaker have but little in common beside their humanity. Now, in Mysore, we have the well-known caste of julgars (gold washers), not very numerous at present, perhaps, yet so well known that the commonest ryot can tell whom you want when you ask for a julgar, thus showing how common the calling must have been at one time. They are to be found in some numbers in the vicinity of known auriferous localities throughout Mysore, and their presence is, in a measure, indicative of the richness of the reefs there found. One other fact which goes far to prove that gold was commonly found in the country, is to be seen in the geographical nomenclature of the province. Scattered all over this area are rivers, hills, towns, villages, and even whole districts, whose names are made up of a prefix, meaning gold, and a distinguishing terminal. It is not to be expected that so important a mineral as gold would have escaped the attention of the various races who have at different periods conquered the country; and that it did not may be learnt from the fact that we have Sanscrit, Tamil, and Kanada expressions, meaning gold, to designate places from whence this mineral was obtained. Thus the Sanscrit for gold is *suvarna* and *hemma*. So we have the rivers Survana-mukhi (gold-face) in the Kolar district, and Survana-vati (gold-feature) in Chamrajnuggar, and the village of Survana in the Honali taluq. Shemoga; Hemavati, a tributary of the Cavery, and Hemagiri (gold-hill), a large bund across this river in the Narsipur Taluq. In Kanada, gold is *Honna* and *Chinna*, and we have Honnu-Hole, Honnali, Honnavalli Honni Kambli, Bhatta, Honavar, and Chinnagherri. In Tamil we have Ponaar, Ponoor—*pon* being Tamil for gold.

PUBLIC INSTRUCTION IN THE PROVINCE OF BOLOGNA.

Consul Colnaghi states that the law of compulsory instruction passed by the Italian Parliament in July, 1877, has with satisfactory results been put in force in the commune of Bologna, where nearly the full complement of children required by law to be under instruction are present at the schools, with the exception of the mountain and country districts, where material

obstacles as well as moral often bar the way to instruction, and the greatest difficulties have to be met by the officials, on whom the execution of the law falls; there is, however, stated to be a serious defect in the law, which is, that instruction is compulsory only between the ages of six and nine, and to remedy this an attempt has been made to establish evening complementary schools. At the schools belonging to the commune of Bologna, religious instruction is no longer given; a clause in the Casarti law of 1859 was somewhat irregularly interpreted to effect this change, which has been in force since 1870; the effect of the abolition of religious instruction has, however, not been to decrease the number of attendants at the schools. Instruction in gymnastics is obligatory, and has been introduced in the schools of the commune of Bologna as well as in those of Imola, San Giovanni in Persiceto, S. Georgio di Piana and other districts. Elementary gymnastic movements performed in school time on the benches are carried out in all the schools of the province. The number of schools in the province of Bologna in the year 1878-9 was 45, in addition to which there were 215 public evening schools for adult males, and 192 public fête day schools for adult females. Of the masters engaged in teaching at the evening schools, 6 are ecclesiastics, and 209 laymen, 210 hold permanent, and 5 provisional diplomas. Of the mistresses of the fête day-schools, 183 are provided with permanent, and 9 with provisional diplomas. The evening schools are open only during the winter months, the fête day schools during the whole year. In addition to the municipal grant there is a Government subsidy of 1[illegible]50 lire to be divided among the 407 teachers in the proportion determined by the provincial scholastic council. For secondary classical instruction the city of Bologna possesses a royal Lyceum with 101 scholars, a communal gymnasium with 235, an archipiscopal seminary (lyceum and gymnasium) with 93, a private lyceum and gymnasium with 91, and two other private gymnasia, one with 76 and the other with five scholars. The city of Imola contains a communal school with 54 boarders and "externes," and an episcopal seminary with 24 scholars. Secondary technical education is given in two communal technical schools, one divided into two sections at Bologna with 330 inscribed scholars, and the second at Imola with 63. Bologna maintains an upper female school with 76 pupils, 30 in the preparatory class and 46 at the school. There are two Government normal schools for the instruction of masters and mistresses for the elementary schools; they are provided with 22 teachers, and are attended by an average of about 200 students. For higher education the celebrated University of Bologna still flourishes, and maintains a good reputation by the assistance of distinguished professors; it contains four faculties—jurisprudence, medicine and surgery, mathematical and physical sciences (to which a school of application for civil engineers, maintained in part by the Government and partly by the municipality, province, and other institutions has been added), and philosophy and letters, with various minor classes, and is frequented by about [illegible] students. The Royal Technical Institute, established in 1862, is also very well attended. The province of Bologna is also largely endowed with charitable educational institutes; in the city of Bologna alone, the total patrimony enjoyed by institutions of this description, which included, upper, secondary, and professional schools, an asylum for the blind, orphan asylums, schools for the deaf and dumb, and purses for poor students, amounted, in 1871, to 11,202,638 lire, with an annual income of 792,846 lire; in the rest of the province the patrimony of similar institutions amounted to 1,948,604 lire, with an annual income of 110,[illegible] lire. Among the principal institutions in the city of Bologna is the Spanish College, which was founded in 1[illegible] by Cardinal Albornoz, and which still receives students, though not necessarily of Spanish birth, who attend the university lectures and the technical schools, Valeriani and Aldini, founded by the two celebrated professors of those names, the first as a school of design for artisans, the second as a physical and chemical cabinet, applied to arts and manufactures. These schools, united by the municipality, now give instruction to sixty-two pupils of the working classes. The Chamber of Commerce has recently annexed to them a school for the moral education of youthful artisans between the ages of thirteen and sixteen. Consul Colnaghi in his report states that an important legacy was left by Dr. Francis Alberghetti to the commune of Imola. By the terms of his will the capital amount left to the commune was to be invested for thirty-one years, at the end of which period half was to be devoted partly to the establishment of a school attached to the local gymnasium for teaching mathematics applied to the arts, and in part to reward any inventions that might be deemed worthy in connection with art, industry, or agriculture. The other half is to be placed at compound interest, for another period of thirty-one years, when the same division is again to be gone through. The first division of the property will take place this year, when 486,085 lire will be available for the purposes mentioned; in 1911, the amount to be divided will be 791,042 lire; in 1941, 1,435,902 lire, and so in a constantly increasing ratio. If the commune of Imola fail in carrying out the wishes of the testator, the legacy reverts to the commune of Bologna.

GENERAL NOTES.

International Medical and Sanitary Exhibition, 1881.—This Exhibition, organised by the committee of the Parkes Museum, was closed on Saturday, August 13th, when the number of visitors, exclusive of season ticket-holders, was 1,221, making a total of 24,333 visitors for the four weeks during which the Exhibition has been open, allowing for one visit only by each season ticket-holder. The closing of the Exhibition was taken advantage of by the St. John Ambulance Association, to give a demonstration of ambulance practice, and during the afternoon a large number of the visitors assembled in the conservatory to witness the practice. Prizes were competed for by squads of the Grenadier Guards, the Finsbury Rifles, and the Metropolitan Police. It is expected that the prizes which have been awarded to exhibitors will be distributed at the annual meeting of the Parkes Museum in the autumn. The preparation of a design for the diploma was entrusted to Mr. Cave Thomas, who has produced a composition, in the centre of which is a female figure, representing Sanitary Science, at the prow of a boat, in the act of casting out a life-buoy.

Electric Lighting.—The station at King's-cross is now lighted by the Crompton electric light. There are 12 Crompton lamps within the station, six above the arrival platform, and six above the departure platform. Two others of a larger size are placed on the outside of the building, at the extreme corners of its front. These lights are worked from five Burgin dynamo-electric machines, driven by a steam-engine of 12-horse power nominal. The area to be lighted consists of two bays, each 105 feet wide, and the cab-rank adjoining the arrival platform, which is 40 feet wide. The total length is 880 feet, and the height to the top of each bay is 72 feet. The total area to be lighted is, therefore, 220,000 square feet, giving an area of 18,333 square feet, or nearly half an acre to each lamp. The lamps are suspended at a height of 30 feet from the platform level. Within the station they are arranged on four distinct circuits, each circuit supplying three lamps. The light of each lamp is about equivalent to 4,000 candles. The two lights hung outside the station are of considerably greater power, being about 6,000 candles each. They are placed on a separate circuit, which has thus to supply only two lamps, as compared with three in the case of the circuits which work the interior lamps. These lamps are placed at the height of 70 feet. The lighting was officially started on the evening of the 11th ints.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, is now open daily. A non-transferable season ticket will be sent to any member of the Society on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE SCIENTIFIC PRINCIPLES INVOLVED IN ELECTRIC LIGHTING.

By Professor W. Grylls Adams, F.R.S.

Lecture III.—Delivered Monday, March 21, 1881.

Use of magneto- and dynamo-electric machines for electric lighting.—Electric lighting by means of the arc.

The fundamental principles which underlie all magneto-electric machines are the four great principles discovered by Oersted, in 1819, by Ampère and Arago, in 1820, and by Faraday, in 1831. In 1819, Oersted discovered the action of a current of electricity on a magnet. In 1820, Ampère discovered the action of magnets and currents on currents of electricity in their neighbourhood, and in the same year Arago showed that currents of electricity produced magnetisation, thus laying the foundations of electro-magnetism; and in 1831 Faraday showed that induced currents were produced by the motion of magnets. All machines for the conversion of work into electricity are founded on Faraday's great discovery of the induced current, derived from the relative motion of a magnet and a coil of wire.

Magneto-electric machines are divided into two great classes, according as they furnish continuous currents or alternate currents. All such machines are alternate, as far as regards the currents in the coil; but these currents are made to flow always in the same direction in the external circuit, in continuous current machines, by means of a commutator which reverses the contact at every half-turn.

The machines of Pixii, in 1832, followed by those of Saxton and Clarke, were the first continuous current machines. From these we may pass to Wheatstone's introduction, in 1845, of electro-magnets in place of permanent magnets, to produce the magnetic field. In 1854, Messrs. Werner Siemens and Halske introduced the Siemens armature, in which the coil is wound longitudinally in a groove. The strength of the continuous current depends on the velocity of rotation, on the length of the wire, and on the power of the magnetic field formed by the magnets.

It is remarkable that, in 1854, Hjorth originated an idea which was some 13 years in advance of his time; he patented an improved magneto-electric battery, in which the currents induced in the revolving armature pass round the electro-magnets, and increase their magnetism, and so increase the induced currents at compound interest rate. This was the celebrated principle afterwards re-discovered by Siemens and by Wheatstone simultaneously in 1867, which has formed the basis of all dynamo-electric machines, and which, for equal power, are cheaper and more compact than all other magneto-electric machines.

Dynamo-electric Machines.

In February, 1867, Dr. Siemens and Sir Charles Wheatstone, on the same evening, presented to the Royal Society their two papers, "On the augmentation of the power of a magnet by the reaction thereon of currents induced by the magnet itself." According to the principle then put forward by Dr. Siemens, the rotating armature, the electro-magnet, and the external resistance, such as an electric lamp, are joined up so as to form one simple circuit. A small amount of magnetism is communicated to the electro-magnet, so that, on rotating the coil, a current is induced alternately in opposite directions, and after being reduced to the same direction by a commutator, this current passes through the coils of the electro-magnet in such a direction as to make it stronger, so enabling it to react on the armature. Thus the magnet and the armature act and react on one another, strengthening the magnetic field, and continually strengthening the induced currents. Sir Charles Wheatstone put forward the same principle, and called attention to the fact that at the first instant of completing the combined circuit the effects are stronger than they are permanently. The principle of these dynamo-

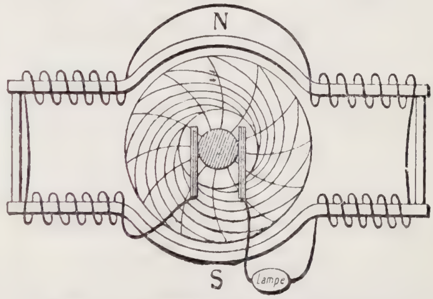


Fig. A.—Dynamo-Electric Machine.

electric machines is clearly shown in the figure A, where N and S represent the poles of the electro-

magnet enclosing the revolving armature, the external resistance in the circuit being represented by an electric lamp. Sir Charles Wheatstone also pointed out that a very remarkable increase of all the effects is observed, when a shunt is employed to divert a great portion of the current from the electro-magnet. By that means four inches of platinum wire, ·0067 in. diameter, was made to glow. A certain resistance in the shunt was found to be necessary to produce the best effects, so as neither to weaken the magnetism too much, nor to give the current too much work to do in heating a high resistance.

In addition to this, Sir Charles Wheatstone showed that the effects above described are far inferior to the effects obtained by placing the work to be done in the shunt circuit. Thus seven inches of wire were made to glow in the shunt, when only four inches of the same wire would glow in the original circuit. There is thus a double advantage, for there is no loss of resistance by introducing the shunt, the resistance of the shunt being the resistance on which the useful work is done.

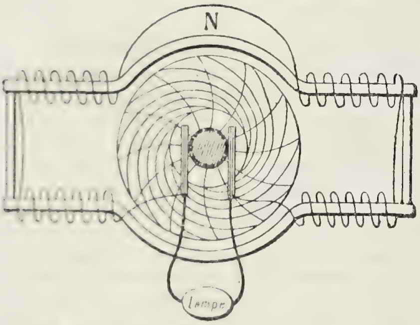


FIG. B.—DYNAMO-ELECTRIC MACHINE.

This improvement, suggested by Sir Charles Wheatstone in 1854, and now being adopted by Dr. C. W. Siemens in his latest dynamo-electric machines, is very well shown in figure B, for which, as well as for the other figures illustrating this lecture, I am indebted to the kindness of the Director of *La Lumière Electrique*.

Wheatstone also showed that the effects are much less influenced by a resistance in the electro-magnet branch than in either of the other branches. Thus, with about four inches of glowing platinum wire in circuit, the addition of about five inches of platinum wire in the armature branch, or in the shunt, produced a $\frac{3}{4}$-inch glow, whilst four feet of the same wire was required in the electro-magnet branch to reduce the glow to three-fourths of an inch. Dr. Siemens has shown that, for the greatest efficiency, the resistance of the rotating coil must be small, but the resistance of the electro-magnet may be increased, and that in both cases the wires should not be small, but of considerable diameter.

THE GRAMME RING.

In the Gramme armature, coils of wire are wound in sections, all in the same direction, round a ring; and each section, when a current is flowing through it, may be regarded as an electro-magnet. The similar poles of all these sectional electro-magnets will point in the same direction round the ring. Consider only one of these electro-magnets with its north pole directed towards the south pole of another magnet, it will be attracted towards it, and with greater and greater force the nearer it approaches; on passing the south pole, its own south pole will be presented to the south pole of the fixed magnet which it has just passed, and its motion will be continued in the same direction.

Now, suppose no current to be flowing in the ring, then, on applying force to produce the same motion as before, the induced current will be in the opposite direction, *i.e.*, as the coil revolves towards the south pole and past it, the induced current in the coil is round the ring, as we look at it from behind, in the direction opposite to the motion of the hands of a watch.

With right-handed winding of the wire on the ring like a cork-screw, the current is coming towards the observer, or in the opposite direction to the motion of the ring on the side nearest the south pole.

If we consider a section of the ring as it approaches and goes away from the north pole of the magnet, the induced current in the coil, as the observer looks at it from behind, will be in the same direction as the hands of a watch move, so that the current will be away from the observer, or in the same direction as the motion of the ring on the side nearest the north pole. Hence, currents flow opposite ways round the ring in the two halves of the ring, and meet at points equidistant from the two poles.

DYNAMO-ELECTRIC MACHINES.

When the armature of a dynamo-machine is turned, the amount of work which is produced by means of it is proportional to the number of turns of the armature per minute. If the same current passes through the electro-magnet and the armature, then the current in one acting on the current in the other will attract or repel it with a force proportional to the product of two currents, *i.e.*, to the square of the current. The action between the currents is increased four-fold, when the current in each is doubled. Hence, when such a machine is used as a generator of an electric current, the external work which can be done by that current in the electric arc or elsewhere is proportional to the square of the current.

USE OF SEPARATE EXCITING MACHINE.

In all dynamo-electric machines, where the same current passes round the magnet and the armature, any disturbance in the resistance of the outer circuit, in the electric arc for instance, at once alters the current, and this alters the strength of the magnetic field, which again produces a further disturbance in the current, so that any disturbance is intensified, just as the permanent magnetism of the iron core is intensified by the action of the current in the machine on itself.

To obtain greater regularity, Wilde, in 1863 proposed to employ a separate continuous current machine to give a permanent magnetic field, and to revolve the armature of the second machine between the poles of the magnet which is excited by the first machine. In order to find the yield of effective work of these machines, and their efficiency

for electric lighting or for other purposes, we have seen, from the laws of Ohm and Joule, that measurements of current, and of the work done by the current, must be made.

In the last lecture I indicated four methods of making such measurements, viz. :—

1. The galvanometer method,
2. The heat method, *i.e.*, by the change of temperature produced by the current in a wire of given resistance.
3. The electrometer or potentiometer method.
4. The electro-dynamometer method, *i.e.*, by the attraction between different parts of the same current.

EFFICIENCY OF MAGNETIC AND MAGNETO-ELECTRIC MACHINES.

If we take a battery in a closed circuit, we know, from the laws of Faraday, that the amount of current produced is directly proportional to the weights of the chemical elements decomposed in each of the cells of the battery, the quantity of zinc dissolved in the battery being a measure of the quantity of current which has passed. According to the laws of transformation of energy, the work done in the chemical actions is here equivalent to the work done in heating the circuit. We may express the energy or the work done by electric currents in the same way as we express the energy of a head of water by the pressure multiplied by quantity of water. The electro-motive force corresponds to pressure, and the current flowing to the quantity of water, so that the work done by the current is the product of electro-motive force by the quantity of electricity.

The work which can be done in the circuit is $E_0 C_0$, where E_0 is the electro-motive force of the battery, and this is spent in heating the resistance. Hence, $E_0 C_0 = C_0^2 R$, where C_0 is the current produced through a resistance R. Now, if any portion of the circuit, carrying a current, be set in motion, under the action of exterior magnetic forces, or under the influence of the mutual reactions of the currents in the fixed and movable parts, then the equivalent to the chemical actions in the battery will be spent in producing the heating of the conductor, and partly in doing the work of the electro-dynamic or magnetic forces. Representing the work done in producing motion by K, and the current in this case by C, we get $E_0 C = C^2 R + K$. The work K is equivalent to the external work done by the current C. Now, this external work K gives rise to an opposing electro-motive force in the induced circuit, and the energy of this induced current is $E C = K$: or $E = \frac{K}{C}$ is the electro-motive force due to induction.

The efficiency of an induction machine, when used as a motor, is the ratio of the work K to the total work $K + C^2 R$, *i.e.*, the ratio of the electro-motive force of induction to the total electro-motive force of the battery. The efficiency

$$\rho = \frac{E}{E_0} = \frac{K}{K + C^2 R} = \frac{1}{1 + \frac{C^2 R}{K}}.$$

The effective work $K = E C$ and $C R = E_0 - E$.

Therefore, $K = \frac{E.\ (E_0 - E).}{R}$

If, then, a battery of electro-motive force E_0 be employed, and an induction machine be employed as a motor, then the effective work depends on the product of two quantities, one of which increases as fast as the other diminishes.

Now, if one quantity increases as fast as another diminishes, their product is greatest when the two are equal. Hence such a machine is most effective when $E = E_0 - E$, *i.e.*, when $E = \frac{1}{2} E_0$, so that $K = C^2 R$ and $\rho = \frac{1}{2}$.

Half the work of the battery is then spent in heating the circuit, and the other half in doing the external work. This corresponds to the case where the strength of the battery current is diminished by one-half through the effects of induction. If the same machine be employed to produce a current of electricity by applying external work to it to turn it, then the energy of the induced current is equal to the work done by the currents during the motion, or $K = E C$. If K is greater than E C at first, then the machine will go faster and faster, and E and C will increase, until the product becomes equal to K, when the motion will remain steady. Hence such a machine should give induction currents of the greatest efficiency when used as a motor.

The above conclusions have been arrived at by considering the attractive and repulsive forces between different parts of a battery current, where the electro-motive force of the battery does not change.

MAGNETIC MACHINES.

The same reasoning will apply to the case where a permanent magnet is used in place of the original battery current, a closed circuit being moved in the magnetic field, or a magnet moved in the neighbourhood of a fixed coil. In fact, the theory of Ampère requires that a small closed current should be equivalent to a magnetic molecule, and so a collection of equal small closed currents, all going the same way, and occupying a given area, is equivalent to a collection of equal magnetic molecules with their poles in the same direction, *i.e.*, to a magnet. But a collection of equal small closed currents all going the same way, and occupying a given area, is equivalent to a current around that area.

We may readily express the efficiency of magneto-electric machines by a formula. Taking k to be the effective work done by a unit current in one turn of the armature, and n the number of turns in a minute, and C the strength of the current, the total effective work is $C^2 nk$; and the work done in overcoming the resistance, R, of the circuit is $C^2 R\theta$: hence, by Joule's and Ohm's laws, if E be the electro-motive force,

$$EC = C^2 nk + C^2 R.$$

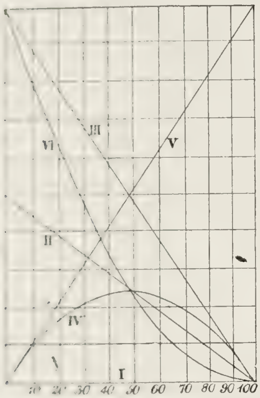
$$\text{Hence the efficiency} = \frac{C^2 nk}{C^2 nk + C^2 R} = \frac{1}{1 + \frac{R}{nk}}$$

Thus, for a given resistance, the greater the number of turns of the machine, the greater is the efficiency, and the higher the resistance, the less the efficiency. This formula shows that machines and lamps of high resistance can only be efficient when the machines are revolving at a high speed.

We may represent the efficiency of batteries or

magnetic machines which are employed to drive an electro-motor, such as a dynamo-electric machine, by a diagram from *La Lumière Electrique*, in which the electro-motive force of the battery or exciting machine is measured on a horizontal line, and either the current or the energy expended is represented by vertical lines. The total electrical energy, represented by a straight line (III.), is the sum of the effective work (IV.), and the loss of energy by heating, &c. (VI.).

Fig. C.



I. Electromotive force.
II. Strength of current.
III. Energy converted into electricity.
IV. Effective work in the external circuit.
V. The efficiency.
VI. Energy not converted into useful work.

It will be seen that when the efficiency is $\frac{1}{2}$, the greatest amount of effective work is produced, and this amount of work is one-half the total electrical energy. Since the electro-motive force is proportional to the number of revolutions a minute, this diagram gives the effective work and efficiency at different speeds.

In the case where the fixed and the movable parts of the machine are electro-magnets, and the same current passes round both, then we have—

(1.) The action of the currents on one another.

(2.) The action of the fixed magnetic core on the moveable coil, and of the moveable magnetic core on the fixed coil.

(3.) The action of the two magnetic cores on one another.

Hence the value of k is of the form $a + bm + cm^2$, where a, b, c are constants, and m depends on the magnetic properties of the cores.

Each of these actions arises from the influence of two equal currents on one another, and, therefore, will be proportional to the square of the current, and to the number of turns of the coil in a minute, so that

$$K \text{ is proportional to } n\,C^2\,(a + bm + cm^2)$$

and the efficiency—

$$\rho = \frac{1}{1 + \frac{C^2 R}{K}} = \frac{1}{1 + \frac{R}{n\,(a + bm + cm^2)}}.$$

The most important part of the action in such machines depends on the action of the two magnetic cores one upon another. The reactions between the fixed and the moveable cores produces great disturbance, in consequence of the cores not taking up their full magnetism instantly, but requiring time for their full magnetisation. In consequence of this, in all dynamo-electric machines, it is necessary to allow the rotation to go on, through an angle determined by the retardation of the magnetism of the cores, before taking away the current from the machine to do external work; hence, in order to get the greatest current, the springs for making contact must in such cases be shifted round in the direction in which the rotation is taking place. Faraday attributed this retardation to the time required to develop the molecular currents in the molecules of the magnet.

Alternate-Current Magneto-Machines.

In alternate-current machines, there is no commutator for making the current continuous; but the currents from the coil are collected and sent through the external resistance in opposite directions for every half-turn of the armature. The earliest of these was the "Alliance" magneto-electric machine, which has been adopted by the French Government for lighthouse illumination. Holmes converted this into a continuous-current machine, and was the first to produce, in 1858, the electric light on a grand scale for lighthouse illumination. He afterwards removed the commutator, and again converted it into an alternate-current machine.

The four methods of placing the coils on the revolving wheel, in machines for electric lighting, which have been employed in lighthouses, have been summed up by Mr. Douglass:—

1. In Holmes's magneto-electric machine, the bobbins are arranged transversely, with their axes parallel to the axis of rotation around the circumference of the wheel.

2. In Siemens' machines, the wires are lengthwise, and revolve about the long axis of the piece on which they are wound.

3. In Gramme's machines, the wires form a helix around a ring.

4. In the De Meritens machines, the wires are wound as in the Gramme, but are divided into separate parts, which are insulated from one another, and passing in succession in front of opposite poles of magnets, give off alternate currents.

The Siemens Alternate-current Machine.

A central disc carrying bobbins is set at right angles to a shaft, and revolves between two sets of electro-magnets ranged in circles on each side of the disc, having their axes parallel to the shaft. The bobbins have no iron cores, and so the heating caused by magnetisation and demagnetisation of the iron is avoided. The electro-magnets are excited by a small Siemens continuous-current machine.

This is similar to Wilde's dynamo-electric machine, which he produced in 1866, except that in the coils on his cast-iron disc Wilde placed soft iron cores, and arranged them so as to form eight groups of four each. The current from one of these groups excites the electro-magnets, whilst the other seven groups give out the current for external use. Among the more recent alternate-current

machines, arranged so as to be excited by a separate continuous current machine, there is one which has lately been invented by M. Gramme, in which the bobbin of the continuous-current machine, which excites the magnets, is placed on the same axis with the rotating armature which gave the alternate currents, so that the two turn with the same velocity, and the combined machines run at the same rate. This is much simpler than having two machines, and it is called a self-acting machine.

From principles which I have already explained, the greatest amount of effective work or yield obtained from an alternate-current machine, driven by a separate exciter, is not more than 50 per cent. of the electrical work given out by the first machine.

Result of M. Mascart and M. Jamin's Experiments.

M. Jamin has found that, in the Alliance machine for electric light and giving alternate currents, the strength of current can be calculated by Ohm's law, considering the electro-motive force as proportional to the velocity, but replacing the resistance of the bobbins by a resistance about eight times as great. The resistance to be added is proportional to the velocity of the machine.

All theoretical determinations of the efficiency of machines are complicated by the retardation of magnetisation of the magnets, which necessitates a change of position of the commutator in the direction of the rotation of the armature. If this change were not made, then it would be possible, with a bobbin in which the wire resistance was high, to get currents in opposite directions when the coil is rotated at different rates. For slow rotation, the galvanometer needle is deviated to one side; on increasing the velocity of rotation, the current is increased, at last reaches a maximum, and beyond that diminishes rapidly to nothing, and becomes negative; as the velocity is still increased the current reaches its greatest negative value, and then increases again, and may have several such fluctuations.

The efficiency of the Siemens dynamo-electric machines has been examined experimentally by Dr. C. W. Siemens, who has communicated the results of his investigations to the Royal Society, and by Dr. Hopkinson, whose results are published in the "Transactions of the Institution of Mechanical Engineers;" also M. Hospitalier and Messrs. Auerbach and Meyer have experimented on Gramme machines, and M. Mascart and Angot have considered the subject, both theoretically and practically, in some excellent papers which have been given in the "Journal de Physique."

Taking the experiments of M. Hospitalier as given in *La Lumière Electrique*, we get the results, as shown in the diagram.

		Ohms.
The total resistance of the machine before the experiment, was		1·185
,, ,,	of the heated bobbin	.75
,, ,,	of the heated electro-magnet	·72
	Total	1·47

The resistances are laid down on the horizontal line to the scale of 1 c.m. per ohm.

The scale of electro-motive force (I.) is 1 c.m. for 10 volts.

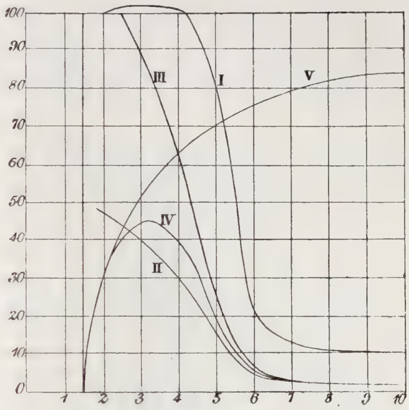
The scale for currents (II.) is 1 c.m. for 10 webers.

The scale for work (III. and IV.) is 1 c.m. for 20 kilogrammètres.

Curve (V.) represents the efficiency, *i.e.*, the ratio of the effective work in the outer circuit to the total work converted into electricity.

This curve expresses the ratio of the external work to the total work produced, and approaches the value unity as the resistance is increased; but for high resistances very little work is produced.

Fig. D.



I. Electromotive force.
II. Strength of current.
III. Energy converted into electricity.
IV. Useful work in the external circuit.
V. Efficiency.

From the curves it would appear that this Gramme machine does most effective work in the outer current, without greatly heating the internal circuit, when the total resistance is about 4 ohms, *i.e.*, when the external resistance is about twice as great as the internal resistance. For less resistances the machine is greatly heated from the amount of internal work consumed, and for higher resistances the work converted into electricity becomes very small. The following numbers give the results of one experiment with the dynamo-machine:—

No. of turns a minute	1,000
External resistance	2·7 ohms
Current	25·5 webers
Electro-motive power	107 volts
Total work converted into electricity	3·64 h.p.
Effective work in external circuit	2·38 h.-p.

The efficiency in this case is 65 per cent. The effective work in the outer circuit is not more than 50 per cent. of the total work done to produce it.

With Gramme Machine.

In Auerbach and Meyer's experiments for 800 revolutions a minute, the maximum electro-motive force is 76 volts, and for 51 volts, or two-thirds of the maximum value, there is a current of 6·5 webers through a resistance of 7·8 ohms. Below this value the current is unsteady. With Siemens's machine, a speed of 700 revolutions a minute gave a maximum electro-motive force of 76 volts, and for 51 volts there is a current of 15 webers through a resistance of ·6654 ohms. With

a small Siemens machine, a speed of 1,000 revolutions per minute gave a maximum electro-motive force of 42 volts, and for two-thirds of this, or 28 volts, the current was 11·2 webers through about 2·2 ohms resistance.

Dr. Hopkinson has investigated the way in which the electro-motive force in a Siemens machine depends on the current. He has shown that:—

(1.) The electro-motive force is for a given current, proportional to the speed of revolution of the armature.

(2.) That the electro-motive force does not increase indefinitely with increasing current, but,

(3.) Only increases in the direct ratio as the current increases up to about two-thirds of its maximum value.

The current is very unstable for small changes of resistance, or of speed of engine, as long as the value of electro-motive force is less than two-thirds of its maximum value. There is a remarkable difference in the ratio $\frac{E}{C}$, depending on change of speed from 660 to 700 revolutions a minute, shown in Fig. 1, where the current changes from 5 to 15 webers, for this increase of one-tenth of the speed.

As regards the relation of work converted into electrical energy to the work expended to produce it, it appears from the experiments of Mr. Schwendler and Dr. Hopkinson that, with the Siemens machines employed by them, the loss of power was from 12 to 14 per cent., so that if the external resistance of the circuit, *i.e.*, the electric lamp, &c., be so adjusted that half the total work produced appears in the arc, then 43 or 44 per cent. of the total work expended is produced in the arc.

The results arrived at by Dr. Siemens with his latest machine on Wheatstone's principle are—(1.) That the electro-motive force, instead of diminishing with increased resistance, increases at first rapidly, and then more slowly towards an asymptote. (2.) That the current in the outer circuit is actually greater for a resistance of $1\frac{1}{2}$ ohms than for one ohm.

With a current of 30 or 40 webers the horse-power expended was 2·44 h.p., and the effective work 1·29 h.p., giving an efficiency of 53 per cent., as compared with 45 per cent. in the ordinary Siemens machine. The maximum energy which can be converted into heat in the machine is 1·3 h.p. The new machine will give a steadier light with greater economy, and may be driven by a smaller engine.

THE BRUSH MACHINE.

Among the later continuous current machines are two which promise to be very successful machines. The Brush, with a ring on the Gramme system, with eight divisions or portions hollowed out to receive the coils, the bobbins at opposite ends of a diameter being connected together and to a commutator. When a pair of bobbins passes the neutral point, so that there is no current in it, it is put out of circuit for one-eighth of a revolution, so that the current produced in the other bobbins is not wasted, by being sent through the resistance of the two which are producing no current. On the inducing magnets are wound fine wires, offering considerable resistance, which carry the current when the external circuit is open, and keep up the magnetism; but when the circuit is closed, the thick wires on the magnets carry the principal part of the current.

The internal resistance of the machine being about $10\frac{1}{2}$ ohms, and the external resistance 73 ohms, there was, according to calculation, a current of 10 webers, and an electro-motive force of 839 volts. With these numbers, the effective work on the external circuit ought to be 87·36 of the whole electrical work produced; but, practically, it is only 61 per cent.

The relation of work converted into electricity to the work expended in this machine, is about 73 per cent., whereas with both Gramme's and Siemens's machines, with relatively smaller external resistances, this ratio is about 88 per cent.

Another continuous-current machine is the Bürgin machine from Switzerland, which has only just been introduced into England by Mr. Crompton.

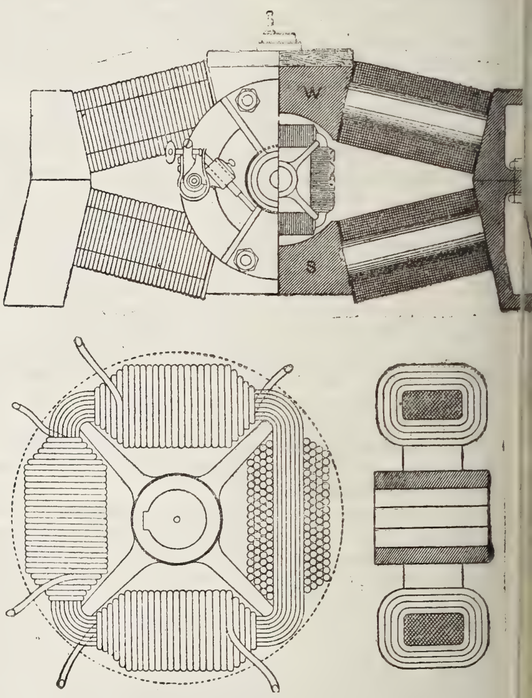


FIG. E.—THE BÜRGIN MACHINE.

Four or six coils are wound on the sides of a square or hexagonal frame, consisting of iron wires. The corners of the frame come very near to the poles of the magnets. There are six or eight of these frames arranged successively in the form of a helix. The action is similar to that of the Gramme machine, the dynamo-electric principle being introduced in this as in other machines. The construction of the machine is very simple, and its efficiency has been proved by M. du Moncel and also by Mr. Crompton to be remarkably good. These machines are of small internal resistance, and are driven at high speeds (up to 1,600 revolutions a minute), so that there is considerable electro-motive force.

The efficiency of certain Gramme machines ex-

hibited by Mr. Crompton, and tested at the Glasgow Electric Light Exhibition, was shown to be such that, with a power of 4 h.p. expended in producing the current, only ½ h.p. was expended on friction and passive resistances, so that about 88 per cent. was nett power. This 3½ h.p. converted into electricity gave a current of 32 webers through a resistance of about 2 ohms, *i.e.*, an internal resistance of 1·077 ohms, and the arc of a Crompton lamp giving a light equivalent to 2,158 candles.

Now, we may compare with these the results obtained by Mr. Crompton for the Bürgin machine, running at a speed of 1,675 revolutions per minute.

Five machines were tested, and the total work expended was 5·45 h.p. The amount spent on friction and passive resistances, when the circuit was open, was about ·25 h.p., so that about 86 per cent. is nett power. The work converted into electrical energy, 5·2 h.p., gave a current of 20·15 webers, through an internal resistance and conducting wires of 2·8 ohms, together with the arcs of 3 Crompton lamps (about 5 ohms), each giving a light of 2,103 candles, measured horizontally; the electro-motive force $= \frac{\text{work}}{\text{current}}$ being equivalent to 163 volts.

With photometric measurements made horizontally, the electric light being level with the gaslight, the carbons being concentrically adjusted, and the length of the arc being about 3 m.m., the greatest amount of light was found to be obtained at 1,675 revolutions per minute, with 3 lamps, each of 2,103 candles, or with 4 lamps, each of 1,246 candles. The upper carbon was 10 m.m., and the negative carbon 13 m.m. in thickness. The consumption of the upper carbon was 4 c.m., and the lower nearly 2 c.m. per hour. The total horse-power expended was 5·55 h.-p., and the current, with 3 lamps, varied from 18·36 to 21·94 webers, and with 4 lamps, from 16·9 to 19·6 webers. All three lights were very steady, and much whiter than the single lights of Gramme's machine.

Mr. Crompton has been kind enough to lend me, this evening, a new Bürgin machine, about which he gives me the following facts:—It was tried at 1,620 revolutions a minute, and a current of 28 webers was sent by it through 3 lamps, in series. When the arcs were lengthened to one-fourth of an inch each, the current was 24 webers, and the arcs gave a light of 5,000 candles each, the photometric measurements being made in the most advantageous direction.

The British Electric Light Company have been good enough to place at my disposal for this evening, and for my lecture next week, two Gramme machines for trying some of the electric lamps which have been kindly lent to me.

These machines are driven by a steam-engine, lent by Messrs. Robey, of Lincoln, and for the Brockie and other electric lamps I am indebted again to the British Electric Light Company; to Dr. Siemens; to Mr. Crompton; to Mr. Latimer Clark, for the Lontin lamp; for the Rapieff and Wilde electric candle, to Mr. Berly; to the Jablochkoff Electric Light Company for their candles; and to the Anglo-American Electric Light Company for the Brush lamp.

The Brockie Lamp.

The upper carbon is attached to an iron tube, which passes into a solenoid, through which it passes as the positive carbon burns away. The solenoid forms a shunt or by-pass for the arc, and takes a small part of the current, and holds up the iron tube which carries the upper carbon; as more current passes through the coils, the motion of the carbon is stopped.

A commutator is so arranged and driven by the dynamo-machine as to break the current, and allow the carbons to come in contact for an instant at regular intervals, say every minute. Then the circuit is completed again, the upper carbon is drawn to its proper distance apart, and the light continues. At every minute the light goes out, but instantly relights, and no variation of light is perceived.

Siemens' Differential Lamp.

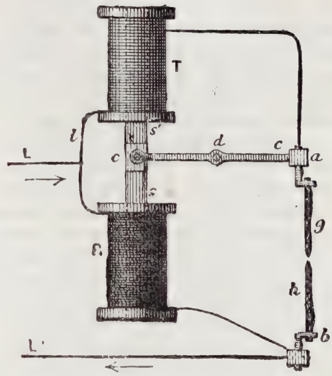


Fig. F.—Siemens' Differential Lamp.

A thick wire bobbin, T, carries the arc current, and another fine wire bobbin, R, forms a shunt to the arc. The interval between the bobbins equals the height of each of them. The iron rod, S S, is of twice the length of each bobbin, and its ends in the normal position are at the centres of the bobbins. The attraction by the thick wire bobbin tends to lengthen the arc and diminish the current, and so its attraction is weakened, and the arc is again diminished, the attraction on the iron being regulated by the change of resistance in the arc. A pendulum arrangement is attached, to prevent the oscillations of the carbon from being too sudden.

Crompton Lamp.

The carbons are brought together by means of the weight of the upper carbon holder, as in the Serrin lamps. The carbons are controlled by means of an electro-magnet, of which the principal armature separates the carbons, and a light secondary armature is arranged on the back of the large one, and does the more delicate work of bringing the carbons together. The large armature supports the negative or lower carbon; and when the small armature has brought the carbons together, so that a current passes, the large armature separates them to the proper distance apart for a good light. When the arc is broken, the armature, supported by a spring, is raised, and brings the carbons into

contact, and re-lights the lamp. The small variations in the strength of current re-act on the second armature, which is held at some distance above the large armature by a light spiral spring. The small armature carries an arm, which is applied as a brake to a brake-wheel, which is the last wheel of a train of wheels, set in motion by the weight of the positive carbon-rod.

REGULATOR IN BRUSH SYSTEM.

A very pretty arrangement for shunting the current past a lamp (when it is not in use), so that one lamp may be put out without affecting the other lamps in the circuit, is adopted on the Brush system.

The current passes through a solenoid coil, wound with thick wire, and then passes to the upper carbon, through the arc to the lower carbon, and then by the frame to the next lamp. The solenoid holds up a rod of iron, which tilts a ring on one side, through which the carbon passes, and so locks it. To the end of a thick wire of the solenoid is attached a thin wire (150 ohms), which is also wound on the solenoid, and which forms a shunt or by-pass to the arc, taking more and more of the current as the resistance of the arc increases. This thin wire is wound the opposite way, and the current in it relaxes the hold on the carbon, so that it falls slowly, and then takes more of the current. As soon as it does so, it is again held fast. To prevent the carbon from falling too rapidly, it is passed through a vessel containing glycerine, and slides downwards very slowly. The current through the thin wire also passes through another solenoid, which forms a shunt or by-pass to the whole lamp, so as to take all the current past the lamp if it should get out of order. When a considerable current flows by this path—*i.e.*, if the arc becomes an inch long, so that its resistance is greatly increased—the second solenoid draws up a piece of iron, which lets all the current pass and the lamp is thrown out of the circuit.

In the Brush lamp, which is designed to burn 16 hours, there are two pairs of carbons, with the rings on the upper carbons, which hold them by friction, so adjusted that one is held about one-fourth of an inch above the other, and, therefore, the second carbon will not come into action until the first falls or is burnt out.

All the electric candles, such as the Jablochkoff candle, the Jamin candle, the Wilde candle, and the De Meritens candle, consisting of three carbons, are fed by means of alternate current machines, because it is essential that the two carbons should burn away equally. In the Jamin and the Wilde candle the carbons are at first in contact, but when the current passes, one of the carbons is separated from the other, because its holder is set on a hinge, so as to be acted upon by a small electro-magnet through which the current passes.

M. Joubert has found that it is necessary, in order to keep the arc steady with the Jablochkoff candle, that the alternate current in the circuit should have a mean value of eight or nine webers, and that below five webers the arc cannot be kept alight; between the bases of the two carbons forming the candle there is an electromotive force of 40 or 45 volts. The Jablochkoff candle uses up about 66 kilogrammètres of work, of which 33 kilogrammètres, or 4·6 h.p., is converted into heat and light.

When the arc is produced in a magnetic field, either by disturbing it by an electro-magnet, or by placing a frame around it, as in the Jamin candle, it is necessary to have a current half as large again as when the electro-magnet is not in action. One-third of the energy of the current is in such a case spent in producing a strong magnetic field around the electric arc, and is, therefore, so much wasted energy, as far as the electric light is concerned.

MISCELLANEOUS.

THE SYMPATHETIC TELEGRAPH.

The following article on the curious superstition relating to a sympathetic telegraph is taken from the *Antiquary*:—

> Or sympathy, or some connat'ral force,
> Pow'rful at greatest distance to unite,
> With secret amity, things of like kind,
> By secretest conveyance.

So wrote Milton, and so have thought many others, more particularly the famous but credulous Sir Kenelm Digby, who, in 1657, delivered a discourse at Montpelier, "Touching the Cure of Wounds by the Powder of Sympathy," which was afterwards translated into English by R. White, and who is said to have cured Howell the letterwriter's cut hands by the use of the powder at a considerable distance from the wounds. When the mariner's compass came to be generally known, as it was apparently in the twelfth century, the supposed wonders of magnetism seem to have attracted the attention of imaginative minds. Alexander Neckam, monk of St. Alban's (born 1157, died 1217), has the credit of being the earliest European writer to allude to the compass. It was evidently the remarkable movements of the needle that first induced dreamy philosophers to believe that a sympathetic telegraph was a possibility. One description is well known, which Addison contributed to the *Spectator*, "of a chimerical correspondence between two friends by the help of a certain loadstone, which had such virtue in it that if it touched two several needles, when one of the needles so touched began to move, the other, though at never so great a distance, moved at the same time and in the manner." This is taken from Strada's "Prolusions," but earlier writers had alluded to the supposed phenomenon, and Mr. Latimer Clark has collected a curious series of books relating to the subject, which he has sent to be shown at the Paris Electrical Exhibition.* The celebrated Baptista Porta was the first to describe the sympathetic telegraph, which he did in 1558 in his "Natural Magic." He is said to have derived the idea from Cardinal Pietro Bembo (1470-1547), but the observations of that celebrated historian and poet on the subject have not yet been traced.

Daniel Schwenter, of Nuremberg, who wrote under the assumed name of Jacobus Hercules de Sunde, was the next (in 1600) to allude to the supposed instrument. He described how attention was drawn by the ringing of bells by means of bar magnets, and how the letters were formed by one, two, or three strokes to the right or left. His ideas were purely cabalistic, but his description singularly coincides with some of the features

* Mr. Clark has kindly supplied the writer with a list of these books, made by Mr. Frost, Librarian of the Society of Telegraph Engineers, from which, with some reference to the books themselves, this article has been drawn up.

of the modern telegraph. B. de Boot, the author of the "Perfect Jeweller," drew attention to the telegraph in 1609, and then in the year 1617, Famianus Strada published his "Prolusions Academicæ." In this book the author printed those verses describing the imaginary lover's telegraph, which were witten in imitation of Lucretius, and have themselves been constantly translated and imitated by later writers. One of these was the Rev. George Hakewill, D.D., Archdeacon of Surrey, who wrote a curious book full of the learning of his time, which he entitled, "An Apologie or Declaration of the Power and Providence of God in the Government of the World." It is a folio volume, printed in London, for Robert Allott, in the year 1630. The fourth section of the third book is, "Of the Use and Invention of the Marriner's Compasse or Sea Card, as also of another excellent invention, said to be lately found out upon the Load-stone;" and this section contains a versified translation of Strada, of which, as it is less known, a quotation is here given in preference to the original.

Well then, if you of ought would faine advise your friend
That dwells far off, to whom no letter you can send,
A large smooth round table make, write down the Christcrosse row
In order on the verge thereof, and then bestow
The needle in the mid'st which touch't the loade, that so
What note soe're you lift it straight may turne unto;
Then frame another orbe, in all respects like this,
Describe the edge, and lay the steele thereon likewise,
The steele which from the self-same Magnes motion drew;
This orbe send with thy friend what time he bids adieu;
But on the dayes agree first when you mean to prove
If the steele stirred and to what letter it doth move
This done, if with thy friend thou closely would advise,
Who in a country off farre distant from thee lies,
Take thou the orbe and steele which on the orbe was set,
The Christcrosse on the edge thou see'st in order writ,
What notes will frame thy words to them direct thy steele,
And it sometimes to this, sometimes to that note wheele,
Turning it round about so often till you finde
You have compounded all the meaning of your minde.
Thy friend that dwells far off, O strange! doth plainly see
The steel to stirre, though it by no man stirred bee,
Running now heere, now there, he conscious of the plot,
As the steele guides, pursues and reades from note to note;
Then gathering into words those notes, he clearly sees,
What's needful to be done, the needle truchman [interpreter] is,
Now when the steele doth cease its motion, if thy friend
Thinke it convenient answere back to send,
The same course he may take, and with his needle write.
Touching the severall notes what so he list indite.

Dr. Hakewill then goes on to refer to the Annotations of Viginerius upon T. Livius, and as he conscientiously refers to his authorities, he tells us that, on the 1,316th column of his first volume, that author says: "that a letter might be read through a stone wall of three foote thicke, by guiding and moving the needle of a compasse over the letters of the alphabet written in the circumference; but the certainty of this conclusion I leave to the experiment of such as list to make tryall of it."

One year before Dr. Hakewill's "Apology" appeared, Nicholas Cabeus published his "Philosophia Magnetica," and in that work he gave the first picture of the telegraph. It merely showed a round dial with a "lower case" alphabet all round its outer edge, and a magnetic needle loosely attached at the centre. Robert Turner was the first English writer to represent this dial, and this he did in his translation of "Ars Notoria: the Notory Art of Solomon" (1657). His figure is similar to that of Cabeus, with this exception, that he uses an alphabet of capitals in place of one of small letters. He describes the pure steel needle as like that used in seamen's compasses, but of double magnitude, so that after being touched by the loadstone, it may be cut in two, when each needle must be placed in a separate box. In one of Bishop Wilkins's curious books, "Mercury, or the Secret and Swift Messenger: showing how a man may, with privacy and speed, communicate his thoughts to a friend at any distance" (1641), the author alludes to the sympathetic telegraph, although he does not believe in its virtues. His nineteenth chapter is "of those common relations that concerne secret and swift information by the species of sight which are either fabulous or magical," and here he writes, "first of those that are fabulous. In which kind, that of the loadstone is most remarkable, as it is maintained by Famianus Strada in his imitation of Lucretius his stile and divers others."

Besides the authors already referred to, there are a large number of others who either describe the instrument or make a passing allusion to it. Of these the most prominent are H. Van Etten (1624), Pancirollus (1629), A. Kircher (1631), Galileo (1632), Sir Thomas Brown (1646), J. Glanvill (1661), Wynant van Westen (1663), Gaspar Schott (1665), W. E. Heidel (1676), L. H. Hillier (1682), De Lanis (1684), and De Vallemont (1696). It is a singular instance of the way in which we copy one from another, that so many writers should have made mention of this purely mythical instrument, some of them apparently with undoubting faith in its virtues.

In an indirect manner, the name of an eminent statesman is connected with this famous dial. Cardinal Richelieu had private agents in many countries, who kept him so well informed with news, that those who knew nothing of the agents thought it necessary to find some explanation of his early knowledge of events, which seemed to them almost like a prophetic power; so they gave out that Richelieu possessed a sympathetic telegraph. The wily Cardinal blandly denied the rumour with smiles, and was not sorry that those around him should be thrown off the right scent.

Some persons believed that the dial might be made with human flesh. A piece of flesh was cut from the arms of two persons, and, while still warm and bleeding, was mutually transplanted. The severed piece grew to the new arm, but retained its sympathy with the old, so that the former possessor was sensible of any injury that it underwent. When the flesh had grown to the new arms, letters were tattoed upon the transplanted pieces; and on one of the letters of one being pricked with a magnetic needle, the friend at a distance immediately felt a sympathetic pain on the same letter on his arm. This reminds one of Taliacotius and his remarkable operations, which inspired Edmund About to write his curious novel, "Le Nez d'un Notaire," in which he relates the odd results of sympathy between the notary's nose and the arm of the man from whom the flesh was taken.

Allusion has already been made to Addison's remarks in the *Spectator* (No. 241) upon Strada's account, and it is worth mention, as a curiosity of literature, that the celebrated essayist actually repeated his remarks word for word in the *Guardian* (No. 119). One of the latest translations of Strada's verses will be found in an Oxford magazine entitled "The Student," which opens thus:

With magic virtues fraught, of sov'reign use,
Magnesia's mines a wondrous stone produce.

Although the telegraph, about which we have been writing, was purely sympathetic, and no provision was made for a connecting wire, yet some may consider it a curious prevision of what has since been successfully carried out. The dial certainly does appear to have borne a singular likeness to a Wheatstone A B C telegraph. The Rev. Joseph Glanvill looked forward in Charles II's reign to the time when communication of this character would be general. That singular man wrote as follows, in a work addressed to the Royal Society:—

"I doubt not but that posterity will find many things that now are but rumours verified into practical realities. . . . . To those who come after it may be as ordinary to buy a pair of wings to fly into the remotest regions as now a pair of boots to ride a journey, and to confer at the distance of the Indies by sympathetic conveyances may be as usual to future times as to us in literary correspondence."

Butler might laugh at those who propose to

. . . . fire a mine in China here
With sympathetic gunpowder,

but time is apt to transform the dreams of the visionary into practical facts, so that the fanciful philosopher really made a better guess than the common-sense poet supposed.

COOKERY IN WEST HERTS.

The following scheme of the Watford and West Herts Association, for the Improvement of Elementary Needlework and Cookery, has been published:—

"There shall be a central school of cookery, in which lessons in the highest and the humblest branches of the art would be given. As West Herts has no towns large enough to support a permanent school, the school of cookery would not remain in one town, but would pass, with its staff and *batterie de cuisine*, through the leading towns of West Herts—Watford, St. Alban's, Berkhamstead, Hitchin, &c., staying about six months in each town, and returning to its former stations every three or four years. To reach the elementary schools arrangements would be made in each town for training teachers specially prepared in the system which has been for several years successfully carried out at Watford-heath, Berkhamstead, and Bushey. Apprentices of about 17 years would be regularly bound to the association for [three] years, paying an apprenticeship fee of about £10, to protect the association from possible loss on training. Their pay would be [£15] for the first year, [£30] for the second year, and [£45] for the third year, with power on the part of the association to cancel the engagement at any time. After about six months' training, the apprentice would be sent out to teach in elementary schools desirous of having lessons. No charge would be made to the schools for these lessons. The only expenses falling upon the schools would be the cost of furnishing, and of any loss on food, which at the outside should not amount to more than £5 a year. It is probable the Education Department will extend to England the grant of 5s. a head now made in Ireland for cookery. The association might fairly stipulate for a part or the whole of this grant. An apprentice would be able to teach five schools, at an average cost to the association of £6 a year for each school. If managers should prefer to train their own pupil-teachers specially to this work, arrangements would be made to meet their views. As the central school moved through the principal towns of West Herts, it would, it is hoped, supply the wants of the schools by one or other of these means. Cookery is at present taught in the schools of the large towns of England; it is the country schools which are generally deficient in this teaching. By this plan of combination, it is thought that the difficulties which now deter country managers may be overcome. Those who are acquainted with the condition of the poor, as regards cookery, will doubtless sympathise with an effort to impart to them information as to the value of many foods now partially or entirely neglected, and to supply them with instruction in the art on which health and domestic happiness so largely depend. The committee hope to begin work in October. The Watford Public Library Committee, from whom the movement emanates, have placed a room at the service of the association, and are willing to assist to the utmost of their power. It is believed that the school of cookery will be self-supporting. The public willingly pay high fees for instruction in superior cookery, and the work of a successful school of cookery is very profitable. But the furniture must be bought. The estimated cost is £100. To meet this, subscriptions are earnestly asked. They will be gladly received by the treasurer, Hon. Victoria Grosvenor, Moor-park, Rickmansworth; Mrs. Iles, secretary, Watford; or at the London and County Bank. It is also desired to form a guarantee fund, to the extent of £200, before the committee can venture on engaging a lady superintendent, and making a beginning."

The President of the association is the Countess of Verulam, and the Chairman of the Committee for Cookery is the Rev. Newton Price.

PARIS ELECTRICAL EXHIBITION.

The exhibition, held in the *Palais de l'Industrie*, was opened on the 10th inst., by the President of the Republic, but the apparatus is still far from completely arranged. It is expected that by the end of the present month the exhibitors will be able to finish their arrangements. The principal entrance is by the main north pavilion, facing the Champs Elysées. The eastern entrance is occupied by the Siemens electric railway, by which visitors paying 25 centimes extra can visit the building. The other terminal point of this railway is on the Place de la Concorde.

The great hall of the Exhibition is a masonry building, 250 mètres in length by 100 mètres in width. Lofty iron pillars support a semicircular arched roof of glass; they are 8 mètres apart, and carry galleries, the spaces under which contain steam-engines, boilers, and dynamical apparatus. A set of four large Belleville boilers, which are heated by coal-dust, supply 16,000 lb. of steam per hour, or a force equal to 800 h.-p. nominal. There are also Otto gas-engines to the extent of 200 h.-p. more. This is the provision made by the French syndicate, which supplies motor-power for a charge of 33 per cent. on the night receipts. French, English, and Belgian manufacturers have also provided many more steam-engines and gas-engines for use by private contract.

An interesting collection of historical and other apparatus arranged by Mr. H. R. Kempe, is exhibited by the Postmaster-General. Here are shown the first five-needle instrument constructed by Wheatstone, in 1837, and specimens of the development of the needle instrument, from the complicated five-needle to the simplified one-needle instrument, largely used even now in local circuits, and on railways; a number of coils showing similar development, from those constructed in the olden days of electricity to the modern forms as designed by Varley and Spagnoletti; a portion of the Ronalds underground telegraph, as it was tried at Hammersmith as long ago as 1816. Another exhibit is the first A.B.C. instrument of Wheatstone, constructed by him in 1840. This is the well-known magnetic apparatus, and may be compared with Henley's magnetic instrument, as constructed in 1848, and pretty generally used by the old Magnetic Telegraph Company. A specimen of the first submarine cable, tried by Ronalds in 1850, is exhibited, as is Varley's secondary battery, which was long used at the Central Office for the transmission and distribution of time-signals from Greenwich. It is announced that the Technical Committee of the Exhibition are about to organise a series of elementary lectures on some of the inventions exhibited. The Exhibition will not be open to the public in the evening before the 27th inst., but the crowds who visit it daily are very large, and on Sundays and *fête* days there is not enough room for the convenience of the public.

GENERAL NOTES.

Phylloxera Congress.—This congress, which was arranged to be held at Bordeaux from August 29th to September 3rd, has been postponed to October 10th.

Electrical Congress.—The Society of Telegraph Engineers has called an extraordinary general meeting of its members to be held in Paris, on Wednesday, 21st of September next, for the reading of papers, &c., in connection with the Electrical Exhibition.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, is now open daily. A non-transferable season ticket will be sent to any member of the Society on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE SCIENTIFIC PRINCIPLES INVOLVED IN ELECTRIC LIGHTING.

By Professor W. Grylls Adams, F.R.S.

Lecture IV.—Delivered Monday, March 28, 1881.

Subdivisions of the electric current.—Incandescent lamps.—Luminous effects of electric currents in a vacuum, and in various gases.

When gas was first introduced extensively for lighting purposes, many objections were raised to its use, and among them was one which was recorded by Clement Desormes, in 1819, which is summed up in the following quotation :—

"The light is of a disagreeable yellow colour, entirely different from that red and warm gleam of oil lamps; it is of a dazzling brightness; its distribution will be impossible and irregular, and it will be much dearer than oil lighting, and, even if it should be improved, it will still remain much dearer than those lights which we already possess."

Just as Desormes had become accustomed to the red gleam of oil lamps, and objected to the coldness of the yellow gaslight, so, a year or two ago, a similar objection was raised against the electric light, that it was entirely different from the yellow and warm gleam of gaslight; that it is of a dazzling brightness; that its distribution would be impossible and irregular; and that our streets would be left in darkness.

These objections do not seem to be so strongly taken up by the public as they were two years ago, for they have seen several trials of the electric light; and, although there are many difficulties in the way, yet the fact that the electric lighthas all the colours more uniformly blended, and is, therefore, a whiter light than gas, and enables objects to be seen in their true colours, can hardly be urged any longer as an argument against its use. The same argument might be urged for the same reason against bright moonlight, or against the light of day, and in favour of a yellow London fog. The Kyrle Society, in its search after truth and beauty, must surely be strong supporters of the spread of the electric light.

If we turn to the Report of the House of Commons, we find the following statement :—

"A remarkable feature of the electric light is that it produces a transformation of energy in a singularly complete manner. Thus the energy of 1-horse power may be converted into gaslight, and yield a luminosity equal to 12-candle power. But the same amount of energy transformed into electric light produces 1,600-candle power."

The experiments of Mr. Schwendler, of Dr. Hopkinson, and of others, have shown that, both with the Siemens machine and with the Gramme machine, 88 per cent. of the total work expended is converted into electrical energy. Theory has established that, if the external resistance of the circuit is equal to the internal resistance of the battery or magneto-machine, the available work in the external circuit is a maximum.

Suppose, then, that we have 40 Grove's cells, each of ·25 ohms resistance, and of an electromotive force of 2 volts, the external resistance being 10 ohms—

$$\text{Then } Q = \frac{E}{R + r} = \frac{40\ E}{40 \times \cdot 25 + 10} = 4 \text{ webers,}$$

$$\text{And } EQ = 2 \times 4 \times 40 = 320.$$

The work done in the external circuit is $\frac{320}{9{\cdot}81 \times 2}$ = 16 kilogrammetres per second nearly, or about $\frac{2}{9}$ h.p.

A small Gramme machine of the A type, having an internal resistance of 4·58 ohms, and with an external resistance of 4 ohms, gives an electric current of 17·5 webers and an electromotive force of 158·5 volts, giving an amount of work equivalent to 2 h.p., $EQ = 160 \times 17$ nearly = 8 times the energy of 40 cells of Grove.

If we wished to replace such a machine by Grove's cells, we should have to arrange about 80 cells to get the same electro-motive force, and to make each cell about four times as large, or to arrange 320 cells in four sets of 80 in each set, to get the same amount of external work done as by the Gramme machine. This will show how impossible it is to do the work by voltaic batteries which can be done by magneto-electric machines.

The equation, work = EQ, may be satisfied in two ways—either by making Q large and E small, *i.e.*, making what is called a quantity machine which will only do effective work when the external resistance is small; or we may make Q small and E large, *i.e.*, what is called a tension machine, which requires an external resistance large enough to prevent the machine from being overheated, and to satisfy the relation for the greatest amount of external effective work.

Comparison of Two Gramme Machines.

	Quantity.	Tension.
Number of turns per minute	797	967
Internal resistance.................	1·2	4·58
External resistance	1·14	4·00
Current in webers	29·67	17·51
Electro-motive force in volts	81·58	158·50
Work spent to produce current	243	277

Thus we see that the total amount of energy is nearly the same in the two cases, but in one case it is spent in driving a large current through a small resistance, and in the other a smaller current is sent through nearly four times the resistance, and to do this a higher electro-motive force is required. This higher electro-motive force is obtained by increasing the number of turns of wire in the bobbin and in the magnet, so strengthening the magnetic field, and also by increasing the number of turns of the machine.

We arrive, then, at the conclusion that, to overcome higher resistances more effectively, higher electro-motive force, and therefore higher speed, is required. Now our resistances may be so high that an ordinary current of electricity, even from a dynamo-machine, will not pass through it, in which case we have to resort to another method of producing electricity, of still higher electro-motive force, but the quantity produced is then considerably diminished. We have then to take an induction coil, consisting of two coils, in one of which a current of electricity from a battery is passing, and by suddenly breaking and making this current, to obtain great changes of the magnetic field, and hence great electro-motive forces, and so get very powerful alternating currents. We know the effect of checking suddenly the flow of water in a pipe. Sometimes the increase of pressure so produced may be sufficient to burst the pipe, and this is one transformation of the energy of motion of the water. This is analogous to the development of the energy of the induction current by the sudden checking of the electric current in the primary circuit. Water may be raised to a high level by a series of sudden impulses, as in the hydraulic ram. A flow of a considerable quantity of water being suddenly stopped, there is at once a sudden increase of pressure, which is sufficient to lift a valve, and allow a small quantity of water to pass into the reservoir or air-chamber. This air-chamber regulates the action of the flow of water up the pipe from the reservoir, just as the resistance and capacity of the secondary circuit regulate the secondary induction current when the primary current is broken. The action of the induction coil is very well illustrated by the action of the hydraulic ram, the level to which water is raised corresponding to the electro-motive force of the secondary circuit. Just as in the hydraulic ram, the quantity of water raised by the machine is at the best only about 66 per cent. of the quantity used, so in making use of the induction current to do work, or to produce the electric light, it is impossible to convert more than a fraction of the energy of the original current into useful work.

In the two systems of electric lighting to which I wish to draw special attention this evening, we have instances of the two opposite methods of accomplishing the same end, viz., the lighting of moderate-sized rooms by a steady and pleasant light.

The Werdermann or Joel Electric Light.

In the Werdermann system, or the Reynier system, a small thread or point of carbon abuts against a plate or edge of carbon or of copper, and becomes heated by the current so as to give out a glowing light, and gradually consumes away, but more and more slowly as the carbons are more and more improved. In these lamps, kindly lent to me by Mr. Latimer Clark, and in these Joel lamps kindly lent to me by Mr. Joel, who has introduced several improvements into the original Werdermann lamp, the resistance of the contact of carbon is very small, about ·134 of an ohm; hence it will take several of them, 7 or 8 (or perhaps 10), arranged in series in the same circuit, to equal the resistance of the electric arc. To work these lamps of low resistance, only a low electro-motive force is required, and so the result is attained by driving a small resistance dynamo-electric machine at moderately low speed; or by placing a considerable number of lamps in series, so as to make their combined resistance equal to or greater than the internal resistance of the machine. Thus a Gramme machine, revolving at the rate of 1,200 revolutions a minute, giving an electro-motive force of about 130 volts, will give a current of 50 webers through about 10 lamps in series. But this current gives an illumination of 320 candles in each lamp, so that with this current we get an illumination of 3,200 candles in 10 lights. Now, the energy expended to produce this rate of revolution in a Gramme machine, is about 9 or 10 h.p. Hence the Werdermann, or the Joel lamp, gives at least two lights of 160 candles each for each h.p. of energy expended.

Mr. Alex. Siemens lays down, in his paper on "Electric Lighting," that 4 lbs. of coal, costing 15s. a ton, will produce 1 h.p. of energy per hour, and that, if a steam-engine be employed to produce an electric light of 6,000-candle power, the cost would be 5d. per hour. If the same illumination be produced by 15 lights of 400 candles each, the cost would be 2s. 1d., or five times as much. Hence the cost for a 400-candle light would be at the rate of about 1⅔d. per hour.

Now, by comparison, we may get some idea of the price of the electric light when obtained by means of the Werdermann or Joel lamp. If we compare the light obtained by the Joel or Werdermann lamp with that from the 400-candle light from the arc, we get about 320—or, say, 300—candle power in the Joel light for 800-candle power in the other. Hence the price of the electric light from a Joel lamp should be at the rate of 6½d. per hour for a 600-candle power light.

Now, according to Mr. Alex. Siemens's estimate for gas, the price of gas would be at the rate of about 5⅘d.—or nearly 6d.—per hour for the same light. In other words, the cost of the electric light from the Joel lamp would be nearly the same as gas at the rate of 4s. per 1,000 cubic feet.

In estimating the candle power of lamps, it is

usual to place the photometer on the same level with the lamp, so that the surface is illuminated by the rays proceeding horizontally from the lamp. Now, in all lamps, whether Werdermann or arc lights, which are fed by a continuous-current machine, the current passes from the positive carbon to the negative always in the same direction; and in the arc lights, the upper positive carbon becomes worn away into a hollow; hence a portion of this carbon obstructs the light, and the greatest intensity of light is not in a horizontal direction, but downwards, at an angle of about 60° below the horizontal. The illumination in this direction is about three times—or even more than three times —the illumination in the same horizontal plane with the arc; hence, when it is said, in the report of the Glasgow tests, that a dynamo-machine, at 1,200 revolutions per minute, will give a light of 2,060 candles, for an expenditure of 4 h.p.—the light being measured horizontally—we see that the illumination, in a direction inclined downwards at an angle of 60° below the horizon, would be 6,500 candles for 4 h.p. or at least 1,625 candles per h.p. This will also explain why lights fed from continuous-current machines should be placed at a considerable height above the area to be illuminated. This, combined with the fact that it is far more economical to produce one very powerful light by means of a large machine, than several smaller lights to illuminate the same area to the same degree, will explain why Dr. Siemens is erecting his large lamps at so great a height, for the trials of electric lights which we shall shortly have an opportunity of seeing in the City.

Sub-division of the Electric Current.

The next point to which I propose to draw your attention this evening is the sub-division of the electric current.

It will be simplest to regard first the case where there is a battery of given electro-motive force. In this case, according to Ohm's law,

$$E = C\,(R + r),$$

where E is the electro-motive force, C the current, R the resistance of the battery, and r the external resistance. If the poles of the battery be joined by two separate resistances r_1 and r_2,

$$\text{then } E = C\left(R + \frac{r_1\, r_2}{r_1 + r_2}\right).$$

If the resistance of each branch is equal to r, and if C_1 be the current in each,

$$\text{then } E = C\,(R + r) = 2\,C_1\left(R + \frac{r}{2}\right).$$

Let E = 100 volts, R = 1 ohm, and r = 100 ohms,

$$\text{then } 100 = C\,(1 + 100) = 101\,C,$$

$$\text{and } 100 = 2\,C_1\,(1 + 50) = 102\,C_1.$$

Hence nearly the same current flows in each branch as when there is only one wire. If there are 10 branches instead of 2 branches, and if C_x be the current in each,

$$\text{then } 100 = C_x\,(1 + 10) = 110\,C_x,$$

i.e., the current in each branch is $\frac{100}{110}$ instead of $\frac{100}{102}$

If there are 50 branches, and C_y be the current in each,

$$\text{then } 100 = C_y\,(1 + 2) = 150\,C_y,$$

thus the current in each is $\frac{100}{150}$ or $\frac{2}{3}$, and the heating or glowing effect is $\frac{4}{9}$ths of its value with only one branch.

Now, if with 50 branches in multiple arc, we diminish the external resistance of each branch so as to get the same current as at first through each branch,

$$\text{Then } E = C\,(R + r) \text{ at first,}$$

$$\text{And } E = 50\,C\left(R + \frac{r_1}{50}\right) \text{ with 50 branches.}$$

$$\text{So that } (R + r) = 50\,R + r_1,$$

$$\text{Or } r - r_1 = 49\,R.$$

Hence with R = 1 and r = 100 ohms $r - r_1 = 49$ and the length left has a resistance of 51 ohms. The heating of each of these is $\frac{51}{100}$, or one-half of what it was with only one branch. Hence the glowing heat or light from such a resistance will be greater than from the unshortened wire, with the weaker current through it. In this case we get 50 circuits of 51 ohms each, so arranged that the heating effect in each circuit is ·51, or about one-half of what it was at first. Hence the amount of heat radiated from each is one-half of what it was at first. But there are 50 such circuits, therefore the total heat radiated is 25 times as much as it was with only one branch.

If the resistance of the battery and connecting wires is considerable, then we see that the addition of every additional branch circuit takes away greatly from the amount of heat radiated from each branch, so that this plan of sub-division by separate circuits can only be adopted with success when the internal resistance is small as compared with the external resistance. We see, then, that with small internal resistance, there is great gain in heating, and, therefore, in light-giving power, by arranging branch parallel circuits in multiple arc; but when the resistance of the battery and leading wires is considerable, the advantage of this arrangement is small, and very little sub-division is admissible.

Incandescent Lamps.

Now, let us consider the case of currents produced by means of dynamo-electric machines, in which the electro-motive force is not constant in the same machine for the same speed, but depends upon the resistance of the circuit. An electro-motive force of 100 volts produces a current of one weber through a resistance of 100 ohms, and Mr. Swan tells us that this current, through a lamp of that resistance, gives a 60-candle power light. Now, if we reduce the length of the carbon filament in the lamp without altering the current, we reduce the illuminating power in the same ratio. Suppose we take it as four-fifths of the length, *i.e.*, its resistance is then 80 ohms, and we shall get a 48-candle power light from the same current (one weber), *i.e.*, with an electro-motive force of 80 volts.

With two such lamps in series, we shall get two 48-candle power lights, with an electro-motive force of 160 volts, sending a current of one weber through them, *i.e.*, the two lamps should give out a light of six gas-burners of 16-candle power each,

and should be sufficient to illuminate a drawing-room in many of our London houses.

If we consider now how we are to produce this current, we find that a Bürgin machine, by the expenditure of 6 h.p., will send a current of 24 webers through an external resistance of about 7 ohms, giving an electro motive force of 160 volts. If then we take two lamps in series, *i.e.*, 160 ohms, and arrange 24 distinct series, we shall get a combined resistance of $\frac{160}{24}$, or about 7 ohms, allowing for the resistance of connecting wires, and there will be a current of 1 weber through each circuit, *i.e.*, this machine should give us 48 lights each of 48-candle power. With a resistance of 50 ohms in each lamp, the number of lamps which may be supplied from the same machine will be double this number. If we reduce our electro-motive force from 100 volts to 80 volts, with the same length of carbon in the lamp, then we reduce the current from 1 weber to 8-10ths of a weber. This in the same resistance will reduce the illuminating power from 60 candles to a light of about 40-candle power, instead of a light of 48-candle power. Hence, with a given electro-motive force, more light is obtained, and, therefore, greater economy is affected by shortening the length of the carbon in the lamp, rather than by diminishing the current through the same length of carbon. Hence, the best results will be obtained in incandescent lamps by sending through them as strong a current as they will safely stand, and making the length of carbon such that the dynamo-machine employed will send such a current through them.

Take another case:—Suppose we have one lamp of 75 ohms resistance (*i.e.*, about 45-candle power). A Gramme machine or a Siemens's medium-sized machine will give an electro-motive force of 100 volts, and a current of about 25 webers, at the rate of 100 revolutions a minute, through an external resistance of about 3 ohms. Hence, if we have 25 lamps in separate branch circuits, or in multiple arc, we get 1 weber through each from such a machine, and get a light, according to Mr. Swan, of 45-candle power from each. Hence, such a machine will give us about 1,125-candle power illumination. The energy expended would be about 5 or 6 h.-p., so that the illumination would be about 200 candles per h.p.

We have seen above that, with the Siemens's alternate current machine, a 400-candle light requires about half a horse power; so that 1 h.p. will supply two lights of 400 candle power, from an alternate current machine, at the rate of 10d. for 3 hours. The same illumination can be obtained from gas, at 2s. for 3 hours. Now, two-thirds of this cost is for the supply of carbon, which becomes burnt in the arc. Hence, without this consumption of carbon, the expense per h.p. is only 10-9ths of 1d. per hour. Applying this to the case of incandescent lamps, in which our carbons do not wear out, we see that by a proper arrangement of the lamps we may get a 200-candle power light at the rate of 10-9ths of 1d. per hour.

Now, Mr. Alex. Siemens also states, in his paper, that at the rate of 3s. 6d. per 1,000 feet, the same illumination cannot be obtained from gas at less than 2d. per hour. Hence, allowing 8-9ths of 1d. an hour for the breakage of incandescent lamps, the cost of light by gas and by incandescent electric lamps would be nearly the same.

If we allow that only a light of 40-candle power, instead of 60-candle power, can be produced at this rate, still the incandescent light cannot be regarded as an expensive light.

Now, in the absence of any actual determination, let us assume the same law to hold in the Brush system as in the Siemens or the Gramme system. In the Brush system a current of 10 webers is sent through an internal resistance of 10 ohms, and an external resistance of 70 ohms. Now, in the Siemens machine, when the external resistance is seven times the internal resistance, the current is only 1-60th part of its value when the external and internal resistances are equal, and 1-40th of its value when the external is double the internal resistance. The drawback to this arrangement would be, that one-third of the total work expended would be lost in heating the machine.

Taking the Brush machine as worked at present, the difference of potential for each of 16 lamps in circuit is about 40 volts. Hence total difference of potential of 16 lamps = about 640 volts. With an external resistance of 70 ohms, there is a current of 10 webers. Hence, if we arrange incandescent lamps in 10 series, so as to get a resistance of 70 ohms, we shall get 1 weber through each series. Put, then, 7 lamps, each of 100 ohms resistance, in each series, and we shall get 70 lamps from a Brush machine. These 70 lamps are each of 60-candle power, and all are worked by an expenditure of 16 h.p. Hence the candle power is 4,200 candles from 16 h.p., or 262·5 candle power per h.p. If the lamps of this resistance are only heated, so as to give a light of 30-candle power each, then the candle power per h.p. will have to be reduced.

Thus we have seen that it is possible to subdivide the electric current in such a way as greatly to increase the amount of illumination which may be obtained by means of a dynamo-electric machine, especially when the light is accomplished by the incandescent system of Swan, Lane-Fox, or Edison.

The earliest attempt to obtain light by incandescence in a vacuum was made by King, in 1843, who applied continuous metallic and carbon conductors, and heated them by an electric current in a Torricellian vacuum. He was followed in 1848 by Staite, who used an iridium, or an iridium and platinum wire, and enveloped the holder in glass or some other non-conductor. In 1872, Konn employed graphite, and rendered it incandescent in an atmosphere of nitrogen, in which there was no wasting away of the carbon. The same principles have been followed, but with greater promise of success, in the more recent attempts at producing illumination by means of incandescence. The earlier attempts failed, either (1) because of the impossibility of preventing the consumption of the carbon or other material, in consequence of the minute traces of air, which it was impossible to get rid of with the means of exhaustion which were then known; or (2) because of the presence of other gases, such as hydrogen, which exists occluded in platinum and in other substances. It is only quite lately, since our power of obtaining a vacuum has been so greatly extended, and since we have learnt so much

about high vacua from the labours of Mr. Crookes, that Mr. Swan and Mr. Lane-Fox have succeeded in obtaining vacua from which all the air and occluded hydrogen are exhausted, so that their carbon filaments and platinum wire connections remain without being destroyed, even when a current of electricity strong enough to make them give out a brilliant incandescent light has been continuously passing through them for months together. Through the kindness of Mr. Swan, and of my friend and former pupil, Mr. Lane-Fox, I am able to show you this evening how well they have succeeded in producing a brilliant, and yet a steady and pleasant, incandescent light. This is a triumph which many have sought in vain, and which could not have been attained except by combining together the results of investigations which have been recently carried on in several branches of physics.

I cannot conclude this course of lectures without giving my especial thanks to Mr. H. Trueman Wood, who has given me very valuable assistance, by helping me to bring together a large collection of electrical apparatus, in illustration of the interesting subject which I have had the honour to bring before you.

MISCELLANEOUS.

AGRICULTURE IN TRAVANCORE.

Agriculture is here carried on, says *The Colonies and India*, with some measure of practical skill and success derived from lengthened experience, but with most primitive instruments, and needing much improvement as to manuring, rotation of crops, and the preparation of produce for the market. The principal native agricultural products are rice, cocoa-nut and other palms, and farinaceous roots for food, besides coffee, which is cultivated by European planters, with the aid of native labour. Fruit trees also are grown, more or less, by every one, and invariably planted as the beginning of an estate when waste land is cleared.

Rice.

Rice is grown chiefly on irrigated or swamp land, though dry or "hill" rice is grown wherever the soil is sufficiently rich to give a crop, and the rain sufficiently abundant to bring it to perfection. Most of the landed wealth of the country consists of rice or "paddy" lands, which vary greatly, however, in quality and produce, and consequently in value. The price of "paddy" lands varies according to the soil, facilities for irrigation, distance from the centres of population, and the returns they are capable of yielding. Some are worth only 30 rupees to 40 rupees per para (about one-eighth of an acre); others cost up to 70 rupees (say, £24 to £56 per acre). The Government compensation for rice lands taken for public purposes is only 14 rupees per para. Land may be said to be worth generally about 15 years' purchase. The produce of rice lands in Travancore ranges from fivefold to thirtyfold. There is a popular complaint that the land is deteriorating and the return less than in former days, which the old people ascribe to diminished attention to sacred rites and duties, but which arises from exhaustion of the soil through want of proper cultivation. In the southern districts, where tillage is more careful, and manuring better attended to, and the sun hotter, the clouds and rainfall being less, the increase has sometimes been known to be fortyfold; but farmers think they are well off with fifteenfold at each harvest—*i.e.*, twice in the year—and throughout the greater part of the country seven or eightfold, or in the south twelve to fifteenfold must be put down as the usual return. As it costs at least two paras (about two-fifths of a bushel) of grain in wages to sow one para of seed, a return of at least three times the seed sown is necessary to repay expenditure. A tenfold increase would be 80 paras, or 32 bushels, of "paddy," or rice in the husk. When cleaned of the husk this is reduced to half the quantity—say 16 bushels—weighing on an average 64⅓ lbs. per bushel when raw. Old rice would be lighter, down to about 59 lbs. The produce, therefore, of an acre of good rice land may be averaged at 1,044 lbs. The total acreage of rice land under cultivation in Travancore is not exactly known, but a fresh survey and re-assessment are about to be undertaken. The survey of eighty years ago places it at about 400,000 acres; but since then much waste land has been brought under cultivation, and the total acreage cannot probably be taken at less than 500,000 acres. Whereas at the beginning of the century Travancore exported large quantities of paddy and rice (in 1843 no less than 281,000 candies of 654 lbs. each), and imported but a small quantity, the case is now totally reversed—exports being only about 70,000 rupees to 80,000 rupees in value, and imports (duty free) having risen from 4½ lacs of rupees seven years ago to 13¼ lacs in 1879. The produce of the country is, therefore, not sufficient for home consumption at the present time. This arises not only from the diminished production already referred to and from increase of population, but also from the general improvement of the circumstances of the lower castes, who can now afford to eat more rice in place of, or in addition to, fruits and vegetables, coarse roots, and inferior grains. Supposing the cultivated area of rice to be 500,000 acres, and the joint produce of the two crops fifteenfold, or 1,566 lbs. per acre; this divided amongst a population of 2½ millions would give 312 lbs. of rice per head per annum for consumption. Imported rice to the value of 13¼ lacs of rupees would give (at a chuckram per pound) 15 lbs. per head additional.

Cocoa-nut.

The cultivation of the cocoa-nut extends over the whole of Travancore, which has hence been facetiously called Cocoanut-core! Forty-four years ago the total number of cocoa-nut trees was 11,100,000, and the increase since has been so considerable, much waste land having been planted with this valuable palm, that the present number cannot be estimated at less than 15 millions. These are almost invariably too closely planted to obtain full advantage of sun and air; but supposing they stood at the moderate distance of 20 feet apart (which is 109 to the acre) the area covered would amount to 137,000 acres. The soils best suited for the cocoa-nut are the sea-shore, the banks and alluvium of rivers, and level lands exposed to the sea-breeze; these conditinns abound in Travancore. Inland on the mountains the cocoa-nut will grow, but not bear fruit. The young plants generally require watering for the first two or three years, and must be protected from the inroads of cattle until they rise some feet above the ground. Ashes are supplied as manure at the beginning of the wet season, and the ground opened about the roots of the trees, which come into bearing some eight or ten years after planting. A cocoa-nut plantation is one of the most easily managed and most remunerative products of the country. The natives have but to put down the nuts and guard the trees more or less while attending to their other employments, and in due course, a permanent and profitable plantation is created. Europeans, however, seldom attempt such an investment, and few who have done so have succeeded in it. The price of 100 ordinary trees in the southern parts may be stated at about 400 rupees. These would pro-

duce, at a low estimate, say 2,400 nuts, value 34 rupees annually. The produce of the tree is very much dependent on soil and climate. The average of good trees in full bearing has been stated at 120 nuts in the twelve months, while in low and sandy soils it will amount to 200, and in gravel or laterite under 60. Ripe cocoa-nuts are quoted in the Trevandrum market list at somewhat under two rupees per 100. The kernels are dried into "copra" for the manufacture of cocoa-nut oil. The copra is largely exported to other parts of India, as well as the "coir" or fibre surrounding the husk, which is sent to Europe and America. The annual value of this palm exported—nuts, dried kernel or copra, oil and fibre—amounts to 42 lacs of rupees, besides oil, nuts, timber, and leaves for home use. It has been estimated that 60,000,000 of nuts and 15,000 candies of oil are annually consumed in the country. The trees are sometimes tapped for a few months, to procure the sweet juice, which, boiled while fresh, gives a palm sugar, and kept a day or two till it ferments, becomes toddy, a slightly intoxicating drink, somewhat like beer. The toddy also is distilled into arrack or native spirits. Other palm trees are also cultivated. Next to the cocoa-nut comes the palmyra, which is grown only in the drier districts towards Cape Comorin. The palmyra, with its sweet sap and sugar, leaves, timber, and fruit, furnishes a living to a great number of the Thanar caste in Travancore, and in Tinnevelly. The number of trees in 1880 was about 6,000,000. It is probable that no considerable increase has taken place since, as old trees are in demand for their timber, and the slow growth of this palm discourages planting. From 160,000 to 24,000 cwts. of the the sugar (jaggery) of this palm are annually exported, worth something over $3\frac{1}{2}$ rupees per cwt. The beautiful areca palm is planted in damp, clayey soil, on the banks of tanks and rivers. Unlike the cocoa-nut it will thrive at a distance from the sea, and on the hills. It is grown very largely in North Travancore, whence the nuts are carried to the south by Syrian and other traders. The trees will grow two or three feet apart. The areca begins to bear in five years, and continues to produce for twenty-five years. The nuts are sold wholesale at six or eight chuckrams per thousand, and retail in Trevandrum at from eight to thirty-two for a chuckram, according to season and demand. 3,500 candies are annually exported to Bombay and other ports, the value of which is about $4\frac{1}{2}$ lacs of rupees.

Yams.

Roots, vegetables, and fruits form a considerable proportion of the food of the population in Travancore. The forest and hill people dig out wild stringy yam-roots from the jungle as food in the hot season. Every native grows something, if he can, around his own dwelling for home use. The principal cultivated root-crops are yams (*Dioscorea*) of various sorts, the small tubers of which are planted out in the beginning of the rainy season and dug again within a year. Some of these roots grow, under favourable circumstances, to a large size, up to four feet in length and one in diameter. Sweet potatoes, the root of a convolvulus, give good returns within three months after planting, and quantities of esculent arums (*Amorphophallus* and *Colocasia*) are grown in fields furnishing a large supply of food.

Tapioca.

Tapioca, introduced from South America, is now largely cultivated in Travancore, and admirably suited for still more extended use. As the price of rice has risen of late years, tapioca has become the more essential as an article of food. It will grow in any soil, and needs but little care, except to preserve it from the depredations of cattle. After the roots are dug, the stem is cut into pieces about four inches long, and planted some three feet apart, with a little ash or other manure. The root requires occasional weeding and earthing, and arrives at maturity in nine or ten months. Well boiled it is eaten with fish curry. It is sometimes given to cattle. In a green state the root does not keep long, but it can be sliced and dried in the sun, or granted and made into farina. A field of this valuable and nutritious root is planted at but little cost; its yield is very large, and its cultivation highly profitable.

THE POTTERY AND PORCELAIN INDUSTRIES OF JAPAN.

Japanese chronicles claim that the first pottery was made in the year 660 B.C.; it was not, however, until the Christian era that the art made any considerable advances. In the year 1223 A.D., great improvements were made in manufacture and decoration of the ware. From that date to the sixteenth century the great potteries of Owari, Hizen, Mino, Kioto, Kaga, and Satsuma were established. The Rahn-Yaki, or crackled ware, was first made at Kioto, at the commencement of the sixteenth century. The best old Hizen ware, that which is still the most admired, was made at Arita, Hizen, in 1580 to 1585; the old Satsuma dates from 1592. Consul-General Van Buren states that porcelain clays are found in nearly all parts of the country, and the different kinds are usually found in close proximity, and close to canals and rivers, which is of considerable advantage, as affording a means of transport. In all cases every variety of clay used in the manufacture of pottery is found in a natural state; there is no necessity to manufacture the quartzose or fusible clays as is done in other parts of the world, and which adds considerably to the cost of the ware. One of the peculiarities in the clay found in Japan is that it contains both the fusible and infusible materials in such proportions as to make a light, beautiful, translucent, and durable porcelain. At Arita, in Hizen, there is a clay found which contains $78\frac{3}{4}$ per cent. of silica, and $17\frac{3}{4}$ per cent. of alumina; from this clay is made the delicate, translucent egg-shell ware, without the addition of any other matter. From an adjoining bluff a clay is taken which has 50 per cent. of silica, and 38 per cent. of alumina; from this the common porcelain is made. Potters' clay is found in very large quantities in the provinces of Yamashiro, Hoki, Turoo, Iyo, Hizen, Higo, Owari, Mikaera, Idyn, Musashi, and Mino. In the whole of Japan there are 283 localities where the clay is deposited; many of these only furnish inferior clays, but they are all fitted for use in some of the various kinds of pottery. These clays are thoroughly powdered by means of what are called "balance pounders," worked in some localities by water-power, but the work is often done by hand. The powder is then dried, and stored on boards or in flat boxes. This dough does not go through the process of fermentation. The shaping is almost exclusively done on the potter's wheel, which is set on a pivot working in a porcelain eye. As a rule, the wheel is turned by the potter himself, but in Hizen it is kept in motion by means of a band connected with its pivot and another wheel turned by a boy. In making dishes of other shape than round, a crude mould is sometimes used. After the clay has been shaped on the wheel, it is set away for drying, and usually in two or three days it is considered sufficiently dry for smoothing, which is done on the wheel with a sharp curved knife. The material is now made into "bisque," or biscuit, by a preliminary baking in small ovens, when it is ready for painting, if it is to be painted on the biscuit; if not, it is ready for the glazing. In either event it will then go to the large furnace for the final baking. The kilns for this purpose are always built on hill sides, and are joined together, increasing in size from the lower to the higher ones, and in number from four to

twenty-five; these kilns are so constructed that the draught is from the lowest one, in addition to which each kiln has its own firing place. The result of this construction is that the upper ones are by far the most heated, and the ware is arranged accordingly; that which requires the least baking, in the lower kiln, and that which requires the greatest heat, in the upper. These connecting kilns have the merit of being heat saving, but they are usually small and badly constructed, and the heat in none of them is uniform. The glaze is made from the silicious clay and potash extracted from wood ashes. This potash is not a pure white, and this accounts for the dirty colour usually to be observed in unpainted Japanese ware. In different districts the painting varies. For instance, in Owari the greater part of the ware is painted a cobalt blue—the cobalt ore being found in the bluffs near the clay deposits, and is used for painting the cheaper wares, and for this purpose German cobalt is also employed. The painting with cobalt is generally done on the biscuit before glazing. In several districts a very handsome ware is made, and painted on the glaze. For this kind of painting the colours are mixed with a silicate of lead and potash, and baked the third time in a small furnace at a low temperature. The colouring oxides in use are those of copper, cobalt, iron, antimony, manganese, and gold. Japanese porcelain painting may be divided into two categories, decorative and graphic; the first is used to improve the vessel upon which it is placed, and this class includes all the ware except that of the province of Kaga, which would come under the head of graphic, as it delineates all the trades, occupations, sports, customs and costumes of the people, as well as the scenery, flora, and fauna of the country. "Owari ware" is made in the province of that name; it is not as translucent, but stronger and more tenacious than some of the Hizen manufacture. The principal potteries are at a village called Sèto, twelve miles from the sea; in this village there are more than 200 kilns. The ware is mostly painted a cobalt blue, and is merely of a decorative kind, consisting of branches of trees, grass, flowers, birds and insects, all these being copied by the artist from nature. All the Owari ware is true hard porcelain, and is strong and durable. In Hizen, a number of wares are manufactured, the best known kind being the "Eurari," which is made at Arita, but painted at Eurari. The colours in use are red, blue, green, and gold; these are combined in various proportions, but, as a rule, the red predominates. Generally the surface of the vessel is divided into medallions of figures, which alternately have red, blue, or white background, with figures in green or blue and gold. The egg-shell porcelain sold at Nagasaki is made in this province from Arita clay, and this is made from clay with no admixture of fusible matter except that contained by the clay naturally. The province of Satsuma is noted for crackled ware. It is only within a very few years that large vases have been manufactured, and in earlier days the old ware was confined to small vessels. The glaze is a silicate of alumina and potash, and the best ware has a complete net-work of the finest crackles; the painting is of birds and flowers, and noted for its delicate lines of green, red, and gold. In Kioto the ware manufactured is very similar to that produced in Satsuma, but it is lighter and more porous, the decorations are also nearly the same, being of birds and flowers. There is a description of ware made in Kioto, called "Eraku," the whole body of which is covered with a red oxide of iron, and over this mythical figures of gold are traced. That produced in Kaga is *faïence*, and in the style of painting is unlike any other in Japan, the predominating colour being a light red, used with green and gold. The designs with which it is profusely decorated are trees, grasses, flowers, birds, and figures of all classes of people, with their costumes, occupations, and pastimes. The "Banko" ware is made at the head of the Owari Bay; it is an unglazed stone-ware, very light and durable, made on moulds in irregular shapes, and decorated with figures in relief. On the island of Awadji, a delicate, creamy, crackled, soft paste porcelain is made. The figures used in decoration are birds and flowers, but outlined by heavy, dark lines. Consul Van Buren is of opinion that, at no distant day, Japan will be one of the foremost competitors in the pottery markets of the world, on account of the great variety and excellence of the clays, their proximity to the sea, the cheapness of labour, and the beauty and originality of the decorations. Already this important industry has been greatly stimulated by the foreign demand, and by the success of Japanese exhibitors at the Exhibitions of Vienna, Philadelphia, and Paris.

GOLD MINING.

The following report by Mr. Thomas Price to the Chairman of the Placerville Gold Quartz Company, Limited, dated San Francisco, April 16th, 1881, refers, in part, to Mr. A. G. Lock's paper on "Modern Gold Mining," read before the Society, January 19th last:—

"In answer to your favour of the 8th ult., on the subject of gold amalgamation as carried on at the Placerville Mill, I take very great pleasure in replying in detail.

"1st.—Description of mill:—The mill has twenty stamps, each stamp being of an average weight of 800 lbs., each battery of five stamps is furnished with a self-feeder. The self-feeders are connected with a large bin, having a capacity of three hundred tons of quartz; the floor of this bin is placed at an angle of 50 degrees, so that the quartz slides by gravity to the self feeders. The quartz is delivered from the mine by a self-acting tramway to this bin, the fine material passing through a grating, the coarser lumps remaining on the floor of the rock-breaker, both the fine and crushed material falling by gravity into the fore-mentioned bin, so that the ore passes from the mouth of the shaft into the battery, without the aid of any manual labour, with the exception of the labour in placing the large pieces of quartz into the rock-breaker. Cut 1 (enclosed herewith) will serve to show you how the self-feeder is attached, as well as the interior arrangement of the mortar. Cut 2 will show the kind of mortar in use—the gold one, of course, and not the silver one. The mortar has but one discharge, and that in front; the screens are made of thin slotted Russian iron, equal to 450 holes to the square inch; inside of each battery in front is a slip of silver copper plate, 8 in. in width by the total length of the battery. Immediately in front of the battery again is a large silver-plated copper-plate, equal to the total width of the mortar by 3 ft. in length, in front of which is placed again 20 ft. 18 in. sluice, the bottom of which is lined with silver-plated copper-plates, constantly kept in a bright condition. The tailings are now passed over what are known as Hendy's concentrators (there being one for each five stamp battery). Cut 3 (enclosed herewith) together with a printed description of the machine, explains itself. The tailings are now again passed over 20 ft. blanket sluices, and afterwards on a 50 ft. of coarse canvas sluices, or rather sluices lined with such material, and finally over 64 ft. of riffle sluices. The material caught on the concentrators and blankets is passed through an amalgamating pan, and settler, and agitator. Cuts 4, 5, and 6, and the accompanying printed description will explain this part of the operation. The material saved on the coarse canvas and riffle sluices are further concentrated in a Cornish buddle, as are also all the tailings from the amalgamating pan and settler. The quantity of quicksilver placed in the mortars or coffers is regulated by the appearance of the copper-plate in front of the battery;

the quicksilver is fed at intervals of half-an-hour. The blankets are washed every hour; the coarse canvas every three hours. The general arrangement of the mill is fairly represented by Cut 7. The tailings are regularly and carefully sampled; the same have been assayed by me with results varying from mere traces to 75 cents. per ton; in one instance only did they ever reach as high as $\$1\frac{50}{100}$ per ton. We endeavour to arrange, as near as we possibly can, a speed of some 75 drops to the stamps per minute. Of course this could be largely increased, and consequent increase of crushing; but this would be at the expense of losing a much higher percentage of gold. We have never had any trouble with the flouring of the mercury.

"2nd.—I will now make what comments I deem necessary on Mr. Lock's paper, read before the Society of Arts. I had read this paper before, as I am a subscriber to the *Journal* of this Society for many years. (1st.) In the matter of 'gauge of gratings or screens.' The size of the screens should depend entirely upon the fineness of the gold in the quartz. If the gold should be diffused in a finely divided state through the quartz, it is evident that finer crushing must be had than if the gold were coarse. I have given the size of the perforations of our screens. (2nd.) All the protection to the mortar by having the dies rest upon a layer of sand has always been in use. We have not had any broken mortar as yet. The stamp-heads and the dies upon which they strike are of the same size; this we consider a protection to the mortar and stamp-head, that is the layer of sand under the dies. With such fine gold as we have to deal with at the Placerville, we could not expect much fine gold caught in this material. We rely upon our amalgamated copper-plates inside of the battery for this purpose, and I have no hesitation in stating that this is by far the best way to catch the maximum amount of gold. In the early days of gold mining in California, the stamps were used simply for the crushing of the ore, the amalgamation was conducted on the outside entirely, the only gold caught in the battery being coarse particles that could not pass through the screens. Experience has taught the mill men here that this latter method is not only more expensive, but by far less effective. I cannot agree with Mr. Lock when he states, 'I venture to assert that this system of putting mercury into the stamp coffers and using amalgamating plates, is radically wrong.' The difficulties that he speaks of, viz., the loss of quicksilver flouring, does not trouble us. I also claim that the particles of amalgam passing through the screens are caught either on the copper-plates in front, or on the Hendy concentrator, and if any escapes here, why we have the blankets, coarse canvas and riffle sluices, and finally the Cornish buddle.

"The last few weeks I have had some experience with the system designated as 'mercury riffles,' and mercury troughs, as fully described in Mr. Lock's paper. I had to examine a mine where they were in use, having been put in and erected by an experienced Australian mill man. I found the tailings containing an abnormal quantity of gold. The owners found it necessary to change this system to amalgamation on copper-plates inside the battery, with the usual outside appendages, already described. (3.) The statement that the gold is flattened out by pulverisation in the battery is not a fact, as the gold is really brittle, and is rather pulverised into small irregular particles than beaten or hammered out into thin plates. (4.) The flouring of the mercury is not caused by the presence of sulphide of iron, so far as my experience goes, but such is the case when sulphides of copper and lead are present in any considerable quantity. In all of our clean-ups at the Placerville Mill, we have never had any trouble with the 'flouring' or the 'sickening' of the quicksilver. The system of concentrating on blankets, as done in some places, collects not only the gold, but much of the metallic iron produced by the wear and tear of the shoes and dies. (5.) The only way to ascertain the true value of auriferous quartz, assaying only from $\frac{1}{4}$ to 1 oz. of gold per ton, when dealing with hundreds of tons per months is, by a careful system of sampling the tailings. The total clean-up, plus amount in tailings, represent the total amount per ton. We sample our tailings at Placerville by taking a bucket full of tailings at regular intervals of two hours, water and all, from the final tailings through a large filter; at the end of each week the accumulated samples are averaged, and at the end of the month the weekly samples are again mixed, and an average sample taken, which I assay.

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With regard to his comments on my paper read before the Society of Arts on the 19th of January last, I do not think the pages of the Society's *Journal* the proper place for a lengthy discussion; I must therefore refer him, and all others interested in the topic, to my book, where the different systems adopted by each country will be compared and fully discussed. But I cannot help, meantime, remarking that Mr. Price's experience in the matter of loss of gold is strangely at variance with the statements of the highest authorities, a few of whom I will quote.

Professor R. W. Raymond says, in his report to the United States Government, in 1875, that, "with a few exceptions, from one-third to one-fourth of the assay value of the ores now being worked, amounting to several million of dollars annually, is irretrievably lost."

Mr. Walter A. Skidmore gives, as will be seen in the table below, the loss of gold in Colorado at 40, and in California at 27 per cent.

Mr. Almarin B. Paul says that the loss in America "is fully 50 per cent, and in the majority of mills all 60 per cent., of what the ore contains."

Mr. Geo. J. Firmin states that in the Black Hills, Dakota, "they only obtain from 10 to 15 per cent. of the gold," and that the general result of his inquiries throughout the country is, "that not more than 50 per cent. of the assay value is recoved on the average."

Nor are the United States singular in showing such a waste of gold.

Mr. Edwin Gilpin, A.M., F.G.S., the Inspector of Mines for Nova Scotia, reports that since returns have been collected, which enable him to ascertain results, 19,000 tons of pyrites, containing on an average 2 oz. 4 dwt. of gold, and 4 oz. 17 dwt. silver, with a value of £10 10s. per ton, have "been thrown away; in other words, over a million of dollars has been thrown into brooks and swamps during the last 18 years." In a letter to me in March last, he characterises this loss as due to the fact of "the chief idea being to pass as much as possible through the mill, and turn the tailings into the nearest brook."

Mr. Walter A. Skidmore's "table of the losses sustained in gold-mining countries" referred to above, gives—

	Per cent.		Per cent.
Piedmont	35	Australia	25
Hungary	50	Colorado	40
Chili	66	California	27

I have now lying before me a letter written in February last, by Mr. F. Guinness, warden and resident magistrate of the Collingwood goldfields, Nelson, New Zealand, in which he speaks of the melancholy fact that, through the inadequacy of the appliances and the want of knowledge how to extract the gold, the district, after repeated trials, has been deserted, and gold-mining abandoned, "little or no gold being obtained, yet the analyses of the quartz gave results of most hopeful returns, as much as 4½ ounces of gold to the ton having been obtained from stone which Dr. Hector and myself took out of the reef."

But to conclude, it appears to be owing to the nature of the ore with which Mr. Price has to deal, rather than to the efficacy of the appliances employed, that he has so little loss, for we find that the Idaho Company, Grass Valley, California, whose appliances are of the most elaborate character, extending the great length of 270 feet from the centre of the stamp heads, lose about 27 per cent. of their gold, obtaining 47·90 dollars, and losing in their tailings 18·67 dollars per ton of ore. ALFRED G. LOCK, F.R.G.S.]

MICROPHONES AT THE PARIS ELECTRICAL EXHIBITION.

The Paris correspondent of the *Times* sends the following description of the use made of the microphone at the Electrical Exhibition, in order to give to numbers of people in the Exhibition the pleasure of listening, night after night, to the companies at the Opera and at the Théâtre Français. Rooms have been fitted up in the galleries, each with a number of pairs of telephones. Two rooms are devoted to the Opera and two to the Théâtre. The former is the more interesting, for there the actions and features of the performers are of less importance. You enter the room in groups of, perhaps, ten at a time. Each one advances to a wall and seizes a pair of telephones, which he places to his two ears. Each of these is connected with a microphone on the stage of the Opera, one to the right, the other to the left of the prompter, and inclined towards the singers. The microphone to the right of the prompter is connected with the telephone at our right ear, the one to his left is connected with that at our left ear. Thus, while the singer moves to right or left the sounds increase or diminish in the right or left ear; when they advance or recede the sounds increase or diminish in both, and thus we are able to appreciate their movements, and it becomes difficult to believe that the performers on the stage are not directly behind the wall which we are facing. So soon as the telephones are applied to the ears the glorious voices of the finest singers in Paris are heard by us undiminished in purity, beauty, or force, by the strange means which have carried them to us over a distance of a mile. The orchestral accompaniment is somewhat weak, owing to the arrangement of the microphones. We can almost see the singer move about, putting expression into the movement and action; and in no part of the Opera-house can you hear with greater (I might also say with so great) clearness and power as in this tapestried room in the Palais d'Industrie.

THE PAPER MULBERRY TREE.

The United States Minister of Agriculture, in a recent report, calls attention to the largely increasing manufacture of cloth in China, Japan, and the Sandwich Islands, from the paper mulberry (*Broussonetia papyrifera*). In Tahiti and other South Pacific Islands, a species of cloth is manufactured from its bark, known as "Tappa" or "Kapa," and it is said that the finest and whitest cloth and mantles worn by the islanders and the principal people of Otaheite are made from the bark of this tree; it dyes readily, particularly in red, and takes a good colour. The following is the method employed by the native women of Otaheite in beating out the fibre. The cleansed fibres are spread out on plantain leaves to the length of about eleven or twelve yards, and these are placed on a regular and even surface of about a foot in breadth. Two or three layers are thus placed one upon another, great attention being paid to making the cloth of uniform thickness; if thinner in one place than another, a thicker piece is laid over this place when the next layer is laid down. The cloth is left to dry during the night, and a part of the moisture having evaporated, the several layers are found to adhere together, so that the whole mass may be lifted from the ground in one piece. It is then laid on a long smooth plank of wood prepared for the purpose, and beaten with a wooden instrument about a foot long and three inches square. Each of the four sides has longitudinal grooves of different degrees of fineness, the depth and width of those on one side being sufficient to receive a small pack-thread, the other sides being finer in a regular graduation, so that the grooves of the last would scarcely admit anything coarser than sewing silk. A long handle is attached, and the cloth is first beaten with its coarsest side, and spreads very fast under the strokes. It is then beaten with the other sides successively, and is then considered fit for use. Sometimes, however, it is made still thinner by beating it after it has been several times doubled with the finest side of the mallet, and it can thus be attenuated until it becomes as fine as muslin. Should the cloth break under this process, it is easily repaired by laying on a piece of bark, which is made to adhere by means of a glutinous substance made from the arrowroot, and this is done with such nicety that the break can scarcely be detected. In other islands the bark is kept wet and scraped with sharp-edged shells. It is said that the King of the Friendly Islands had a piece made which was 120 feet wide and two miles long. In Japan a species of cloth is made from paper derived from this tree. It is cut into thin strips, which are twisted together and spooled, to be used in the woof of the fabric, while the warp is composed of silk or hemp. About 250 pieces only are manufactured at the principal manufacturing place. The paper mulberry grows everywhere in Japan, and is a valuable tree, as furnishing the bast from which a large portion of the Japanese paper is made; the plants are reproduced in quantity by sub-dividing the roots, and in two or three

years are ready to be cut. This work is done in November, and the branches, from seven to ten feet long, are made up into bundles, three or four feet in length, and steamed so that the bark is loosened and can be more readily stripped off; this is washed, dried, and again soaked in water, and scraped with a knife to remove the outer skin, which is used for inferior kinds of paper. The bast, when cleaned, is washed repeatedly in clean water and rinsed; it is then bleached in the sun till sufficiently white, after which it is boiled in a lye, chiefly of buckwheat ashes, to remove all gummy matters. The fibres are now readily separated, and are transformed into pulp by beating with wooden mallets; the pulp is mixed in vats with the necessary quantity of water, to which is added a milky substance prepared from rice flour. The couches on which the paper sheets are produced are made of bamboo, split into very thin sticks, and united in parallel lines by silk or hemp threads, so as to form a kind of mat. This is laid upon a wooden frame, and the apparatus dipped into the vat, raised and shaken, so as to spread the pulp evenly, after which the cover is first removed, then the bamboo couch, with the sheet of paper. When a number of sheets have been thus prepared, they are pressed to exclude the water, and afterwards spread out with a brush upon boards and allowed to dry. The sheets are only about two feet in length, but sometimes sheets ten feet long are produced.

GENERAL NOTES.

Technical Instruction.—A Royal Commission, consisting of Mr. Bernard Samuelson, M.P., F.R.S., Mr. Henry Enfield Roscoe, D.C.L., F.R.S., Mr. Philip Magnus, Mr. John Slagg, M.P., Mr. Swire Smith, and Mr. William Woodall, M.P., has been appointed "to inquire into the instruction of the industrial classes of certain foreign countries in technical and other subjects, for the purpose of comparison with that of the corresponding classes in this country, and into the influence of such instruction on manufacturing and other industries at home and abroad." Three is to be a quorum. The Commission has the ordinary powers.

Agricultural Returns for 1881.—The Statistical and Commercial Department of the Board of Trade have issued a summary of the returns collected on the 4th of June last, which shows the extent of land in Great Britain under wheat to be [illegible] acres, or 103,381 acres less than in 1880; barley, 2,442,405 acres, or 25,036 acres less than in 1880; oats, [illegible] acres, or an increase of 104,230 acres; potatoes, [illegible] acres, an increase of 28,499 acres over 1880; and hops, [illegible] acres, or a decrease of 1,577 acres. The total number of live stock in Great Britain on the same day is given as—Cattle, 5,911,524; sheep and lambs, 24,582,154; pigs, [illegible].

Adelaide International Exhibition.—Particulars of this Exhibition, which was opened on July 31st, by the Governor, have been received. The Exhibition is reported to have proved highly successful, the demands for space having been so numerous, that it was found necessary to extend the original plan, and to greatly increase the area. The main building is that belonging to the Agricultural Society, to which have been added a number of important annexes, the principal of which contains sixteen courts. These are respectively devoted to Victoria, New South Wales, New Zealand, Tasmania, France, Germany, Austria, Italy, Belgium, Japan, Turkey, China, Switzerland, America, India, and Great Britain. The British Court occupies more than two-thirds of the east side of the annexe, with an area equal to six times that of any other. The miscellaneous exhibits comprise a fair representation of the varied industries of the United Kingdom. In honour of the opening, the House of Assembly adjourned. The Chief Justice, the President of the Legislative Council, the Speaker of the House of Assembly, the members of the Government, and the Mayor and Council of Adelaide, attended the ceremony.

Wool Exhbiition at the Crystal Palace.—The award of prizes by the Jurors of the Exhibition have been announced by the directors of the Crystal Palace. These consist of gold medals, offered by the Clothworkers' Company and Drapers' Company, and gold, silver, and bronze medals, offered by the Merchant Taylors' Company and others. The awards of the Jurors in yarns and chemicals will be announced shortly.

Education Code.—The proposals for the revision of the Code and Examination Schedules, dated 5th August, have been printed as a Parliamentary paper. The following particulars as to the mode by which these proposals were obtained were given by Mr. Mundella, the Vice-President, and are here quoted from a leading article in the *Morning Post*:—"In the first place we had memorials from School Boards and from persons connected with education who made suggestions for the improvement of the Code. We found ourselves able to agree on certain principles; and these papers were prepared by twenty or thirty of our principal inspectors, and we elicited from them the freest possible criticism. Having received these reports, we made a draft report, and agreed, further, that the matter should be thoroughly sifted, and the details worked out by a committee, consisting of Sir F. Sandford, Mr. Sykes, and Mr. Cumin, the three chiefs of the Department, together with Mr. Warburton, who had great experience as an inspector of smaller schools, Mr. Sharpe, as inspector of large schools, and Mr. Fitch, for his connection with training colleges." Over this committee Mr. Mundella presided. When its work was ended, it was yet further sifted, by being referred to an enlarged committee, including Mr. Matthew Arnold and three other inspectors. This was presided over by Earl Spencer, and the result is the document laid upon the table of the House.

Population of Austria.—The following is a summary of the population of the several provinces of the non-Hungarian portion of the Austrian Empire, extracted from the report of the Central Statistical Commission for taking the census last December:—Lower Austria, 2,329,021; Upper Austria, 760,879; Salzburg, 163,566; Styria, 1,212,367; Carinthia, 348,670; Carniola, 481,176; Trieste, Istria, &c., 650,532; Tyrol, 805,326; Vorarlberg, 107,364; Bohemia, 5,557,134; Moravia, 2,151,619; Silesia, 565,772; Galicia, 5,653,170; Bukovina, 560,599; Dalmatia, 474,489; total for the Austrian Crown Lands, 22,130,684. This gives a total increase for the eleven years of 1,734,054, or 8·5 per cent. This is a satisfactory result as compared with the Hungarian provinces, where the increase for the ten years—1870-1880—was only 1·24 per cent. The total population of the Austro-Hungarian Empire last December, was 37,739,407, being an increase for the decade of 1,925,450, to which the Hungarian provinces had contributed only 191,396. While the annual rate of increase in the provinces of the Austrian portion of the monarchy averaged only ·772 per cent., in Prussia it averaged during the last five years 1·179 per cent., being more than one-third higher. The population of the chief towns in the Austrian provinces last December stood thus:—Vienna, 726,105; Prague, 162,318; Trieste, 144,437; Lemberg, 110,250; Gratz, 97,726; Brünn, 82,655; Zara, 60,226; Czernowitz, 45,600; Linz, 41,687.

THE LIBRARY.

The following works have been presented to the Library:—

Portland Cement for Users, by Henry Faija, C.E. (London, Crosby Lockwood, and Co., 1881.) Presented by the Author.

Suggestions as to the Preparation of District Maps, and of Plans for Main Sewerage, Drainage, and Water Supply, by Robert Rawlinson, C.B. (London, 1878.) Presented by the Author.

Three Official Reports of Rigid Local Tests of the Perkins' System of Engines and Boilers. (London, Perkins' Engine Company, Limited.) Presented by Major Deane.

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, SEPTEMBER 9, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, will be closed on Saturday, the 10th inst.

The report of the Judges appointed by the Council, to recommend the awards of silver and bronze medals to the designers and art workmen whose work is exhibited in the Exhibition, has been received, and will be laid before the Council at their first meeting after the recess. The report is signed by Messrs. George Godwin, F.R.S.; Montague Guest, M.P.; Edward J. Poynter, R.A.; and Alan S. Cole, hon. sec.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE ART OF LACE-MAKING.

By Alan S. Cole.

LECTURE I.—DELIVERED MONDAY, APRIL 4, 1881.

Introduction. Early forms of twisted, plaited, and looped threads. Ornamental borders of costumes. Sumptuary laws. Venetian books of patterns for embroidery and lace. Flanders a centre of linen trade of Europe. Spanish and French importations of early lace. Effect of production of machine-made lace upon production of hand-made lace.

I. In undertaking to deliver a course of Cantor lectures upon "The Art of Lace-making," in compliance with a gratifying invitation from the Council of the Society of Arts, I am sensible of the responsibility I incur. I cannot, however, hesitate to claim your indulgence, since the position of lecturer is new to me. An experienced and able lecturer knows at once how to engage the sympathy of his audience. He leads them over difficult ground, making the difficulties interesting, just as a good guide does, who shows you the way up a mountain, through forest and rocky lands, across crevasses, and over snow fields. The tracing of a history of lace-making is not, however, likely to be beset with many difficulties. It covers a considerable space of time—over three hundred years—and involves the consideration, as all history does, of a number of circumstances. A tolerably straight course must, if possible, be adhered to, so that we may not stray off into tempting by-paths. Many works have been written and published upon lace-making, and I can hardly hope to bring to light many facts or reflections which have not been previously placed before the public. If I am successful in adding anything which may assist a true view of the development of lace-making I shall be fortunate.

II. Every one present, I presume, knows what lace is, in the ordinary and modern sense of the word. The shop-windows of linendrapers are filled with it. It is universally worn. About twice a week we may read in our newspapers that the lace trade is full of activity at Nottingham, in Belgium, in France, and elsewhere. If we go abroad, we see lace much like that we have left at home. Sometimes the lace trade is reported to be less vigorous than it was, sometimes it is more. A fair demand is maintained for Coraline and Vermicelli laces, whilst Bobbin, Bretonne, and Mechlin sell pretty well at "late" prices. The market, however, is dull on the whole, and there is no business in Valenciennes. This sort of intelligence usually comes to us at breakfast time, but it is not of the exciting character of some news which spoils our meal. After breakfast, if we happen to have absorbed the intelligence about the lace market, we may go out expecting to find symptoms of it in the shops. Not at all, however. A constant supply of cheap laces is to be purchased.

III. Now, I think that it would take some of us by surprise were an announcement to be made that Parliament had passed a Bill ordering that no lace wider than two inches was henceforth to be worn. What a disturbance this would create amongst lace workers and lace wearers! It would be almost more exciting than many recent points of domestic news. Judging from past events in similar circumstances, the ingenuity of people would be sharpened into all sorts of evasions of the law, both numerous and humorous.

IV. In the 14th, 15th, and 16th centuries, laws regulating costume were in force, and a result of them has been a number of entertaining anecdotes about evasions of them—smuggling, and so forth. An incident in the history of these laws was the imperturbability with which fashion displayed itself to be stronger than the laws. In spite of regulations and edicts, which one might suppose would have prevented people from teaching one another their fashions, and from interchanging their national productions and manufactures, this teaching and interchanging went on generally in an overt way, but still persistently forming and virtually ruling what is called fashion. At the outset of lace-making, difficulties like those just mentioned were imposed upon its development. Nevertheless, fashion has stimulated lace-making, and has raised lace work to an eminence in public favour, the hold upon which modern machinery is certainly striving to perpetuate, by widely disseminating lace of a special class.

V. The plan which I have adopted for my lectures is, roughly, as follows:—First, I propose to make a few observations upon the ability to twist, plait,

the quicksilver is fed at intervals of half-an-hour. The blankets are washed every hour; the coarse canvas every three hours. The general arrangement of the mill is fairly represented by Cut 7. The tailings are regularly and carefully sampled; the same have been assayed by me with results varying from mere traces to 75 cents. per ton; in one instance only did they ever reach as high as $\$1\frac{50}{100}$ per ton. We endeavour to arrange, as near as we possibly can, a speed of some 75 drops to the stamps per minute. Of course this could be largely increased, and consequent increase of crushing; but this would be at the expense of losing a much higher percentage of gold. We have never had any trouble with the flouring of the mercury.

"2nd.—I will now make what comments I deem necessary on Mr. Lock's paper, read before the Society of Arts. I had read this paper before, as I am a subscriber to the *Journal* of this Society for many years. (1st.) In the matter of 'gauge of gratings or screens.' The size of the screens should depend entirely upon the fineness of the gold in the quartz. If the gold should be diffused in a finely divided state through the quartz, it is evident that finer crushing must be had than if the gold were coarse. I have given the size of the perforations of our screens. (2nd.) All the protection to the mortar by having the dies rest upon a layer of sand has always been in use. We have not had any broken mortar as yet. The stamp-heads and the dies upon which they strike are of the same size; this we consider a protection to the mortar and stamp-head, that is the layer of sand under the dies. With such fine gold as we have to deal with at the Placerville, we could not expect much fine gold caught in this material. We rely upon our amalgamated copper-plates inside of the battery for this purpose, and I have no hesitation in stating that this is by far the best way to catch the maximum amount of gold. In the early days of gold mining in California, the stamps were used simply for the crushing of the ore, the amalgamation was conducted on the outside entirely, the only gold caught in the battery being coarse particles that could not pass through the screens. Experience has taught the mill men here that this latter method is not only more expensive, but by far less effective. I cannot agree with Mr. Lock when he states, 'I venture to assert that this system of putting mercury into the stamp coffers and using amalgamating plates, is radically wrong.' The difficulties that he speaks of, viz., the loss of quicksilver flouring, does not trouble us. I also claim that the particles of amalgam passing through the screens are caught either on the copper-plates in front, or on the Hendy concentrator, and if any escapes here, why we have the blankets, coarse canvas and riffle sluices, and finally the Cornish buddle.

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I am pleased to be able to take this opportunity, publicly, to thank Mr. Price for his kindness in so fully answering my questions, and I earnestly hope that his good example will be followed by all who have received a similar list.

With regard to his comments on my paper read before the Society of Arts on the 19th of January last, I do not think the pages of the Society's *Journal* the proper place for a lengthy discussion; I must therefore refer him, and all others interested in the topic, to my book, where the different systems adopted by each country will be compared and fully discussed. But I cannot help, meantime, remarking that Mr. Price's experience in the matter of loss of gold is strangely at variance with the statements of the highest authorities, a few of whom I will quote.

Professor R. W. Raymond says, in his report to the United States Government, in 1875, that, "with a few exceptions, from one-third to one-fourth of the assay value of the ores now being worked, amounting to several million of dollars annually, is irretrievably lost."

Mr. Walter A. Skidmore gives, as will be seen in the table below, the loss of gold in Colorado at 40, and in California at 27 per cent.

Mr. Almarin B. Paul says that the loss in America "is fully 50 per cent, and in the majority of mills all 60 per cent., of what the ore contains."

Mr. Geo. J. Firmin states that in the Black Hills, Dakota, "they only obtain from 10 to 15 per cent. of the gold," and that the general result of his inquiries throughout the country is, "that not more than 50 per cent. of the assay value is recoved on the average."

Nor are the United States singular in showing such a waste of gold.

Mr. Edwin Gilpin, A.M., F.G.S., the Inspector of Mines for Nova Scotia, reports that since returns have been collected, which enable him to ascertain results, 19,000 tons of pyrites, containing on an average 2 oz. 4 dwt. of gold, and 4 oz. 17 dwt. silver, with a value of £10 10s. per ton, have "been thrown away; in other words, over a million of dollars has been thrown into brooks and swamps during the last 18 years." In a letter to me in March last, he characterises this loss as due to the fact of "the chief idea being to pass as much as possible through the mill, and turn the tailings into the nearest brook."

Mr. Walter A. Skidmore's "table of the losses sustained in gold-mining countries" referred to above, gives—

	Per cent.		Per cent.
Piedmont	35	Australia	25
Hungary	50	Colorado	40
Chili	66	California	27

I have now lying before me a letter written in February last, by Mr. F. Guinness, warden and resident magistrate of the Collingwood goldfields, Nelson, New Zealand, in which he speaks of the melancholy fact that, through the inadequacy of the appliances and the want of knowledge how to extract the gold, the district, after repeated trials, has been deserted, and gold-mining abandoned, "little or no gold being obtained, yet the analyses of the quartz gave results of most hopeful returns, as much as 4½ ounces of gold to the ton having been obtained from stone which Dr. Hector and myself took out of the reef."

But to conclude, it appears to be owing to the nature of the ore with which Mr. Price has to deal, rather than to the efficacy of the appliances employed, that he has so little loss, for we find that the Idaho Company, Grass Valley, California, whose appliances are of the most elaborate character, extending the great length of 270 feet from the centre of the stamp heads, lose about 27 per cent. of their gold, obtaining 47·90 dollars, and losing in their tailings 18·67 dollars per ton of ore. ALFRED G. LOCK, F.R.G.S.]

MICROPHONES AT THE PARIS ELECTRICAL EXHIBITION.

The Paris correspondent of the *Times* sends the following description of the use made of the microphone at the Electrical Exhibition, in order to give to numbers of people in the Exhibition the pleasure of listening, night after night, to the companies at the Opera and at the Théâtre Français. Rooms have been fitted up in the galleries, each with a number of pairs of telephones. Two rooms are devoted to the Opera and two to the Théâtre. The former is the more interesting, for there the actions and features of the performers are of less importance. You enter the room in groups of, perhaps, ten at a time. Each one advances to a wall and seizes a pair of telephones, which he places to his two ears. Each of these is connected with a microphone on the stage of the Opera, one to the right, the other to the left of the prompter, and inclined towards the singers. The microphone to the right of the prompter is connected with the telephone at our right ear, the one to his left is connected with that at our left ear. Thus, while the singer moves to right or left the sounds increase or diminish in the right or left ear; when they advance or recede the sounds increase or diminish in both, and thus we are able to appreciate their movements, and it becomes difficult to believe that the performers on the stage are not directly behind the wall which we are facing. So soon as the telephones are applied to the ears the glorious voices of the finest singers in Paris are heard by us undiminished in purity, beauty, or force, by the strange means which have carried them to us over a distance of a mile. The orchestral accompaniment is somewhat weak, owing to the arrangement of the microphones. We can almost see the singer move about, putting expression into the movement and action; and in no part of the Opera-house can you hear with greater (I might also say with so great) clearness and power as in this tapestried room in the Palais d'Industrie.

THE PAPER MULBERRY TREE.

The United States Minister of Agriculture, in a recent report, calls attention to the largely increasing manufacture of cloth in China, Japan, and the Sandwich Islands, from the paper mulberry (*Broussonetia papyrifera*). In Tahiti and other South Pacific Islands, a species of cloth is manufactured from its bark, known as "Tappa" or "Kapa," and it is said that the finest and whitest cloth and mantles worn by the islanders and the principal people of Otaheite are made from the bark of this tree; it dyes readily, particularly in red, and takes a good colour. The following is the method employed by the native women of Otaheite in beating out the fibre. The cleansed fibres are spread out on plantain leaves to the length of about eleven or twelve yards, and these are placed on a regular and even surface of about a foot in breadth. Two or three layers are thus placed one upon another, great attention being paid to making the cloth of uniform thickness; if thinner in one place than another, a thicker piece is laid over this place when the next layer is laid down. The cloth is left to dry during the night, and a part of the moisture having evaporated, the several layers are found to adhere together, so that the whole mass may be lifted from the ground in one piece. It is then laid on a long smooth plank of wood prepared for the purpose, and beaten with a wooden instrument about a foot long and three inches square. Each of the four sides has longitudinal grooves of different degrees of fineness, the depth and width of those on one side being sufficient to receive a small pack-thread, the other sides being finer in a regular graduation, so that the grooves of the last would scarcely admit anything coarser than sewing silk. A long handle is attached, and the cloth is first beaten with its coarsest side, and spreads very fast under the strokes. It is then beaten with the other sides successively, and is then considered fit for use. Sometimes, however, it is made still thinner by beating it after it has been several times doubled with the finest side of the mallet, and it can thus be attenuated until it becomes as fine as muslin. Should the cloth break under this process, it is easily repaired by laying on a piece of bark, which is made to adhere by means of a glutinous substance made from the arrowroot, and this is done with such nicety that the break can scarcely be detected. In other islands the bark is kept wet and scraped with sharp-edged shells. It is said that the King of the Friendly Islands had a piece made which was 120 feet wide and two miles long. In Japan a species of cloth is made from paper derived from this tree. It is cut into thin strips, which are twisted together and spooled, to be used in the woof of the fabric, while the warp is composed of silk or hemp. About 250 pieces only are manufactured at the principal manufacturing place. The paper mulberry grows everywhere in Japan, and is a valuable tree, as furnishing the bast from which a large portion of the Japanese paper is made; the plants are reproduced in quantity by sub-dividing the roots, and in two or three

years are ready to be cut. This work is done in November, and the branches, from seven to ten feet long, are made up into bundles, three or four feet in length, and steamed so that the bark is loosened and can be more readily stripped off; this is washed, dried, and again soaked in water, and scraped with a knife to remove the outer skin, which is used for inferior kinds of paper. The bast, when cleaned, is washed repeatedly in clean water and rinsed; it is then bleached in the sun till sufficiently white, after which it is boiled in a lye, chiefly of buckwheat ashes, to remove all gummy matters. The fibres are now readily separated, and are transformed into pulp by beating with wooden mallets; the pulp is mixed in vats with the necessary quantity of water, to which is added a milky substance prepared from rice flour. The couches on which the paper sheets are produced are made of bamboo, split into very thin sticks, and united in parallel lines by silk or hemp threads, so as to form a kind of mat. This is laid upon a wooden frame, and the apparatus dipped into the vat, raised and shaken, so as to spread the pulp evenly, after which the cover is first removed, then the bamboo couch, with the sheet of paper. When a number of sheets have been thus prepared, they are pressed to exclude the water, and afterwards spread out with a brush upon boards and allowed to dry. The sheets are only about two feet in length, but sometimes sheets ten feet long are produced.

GENERAL NOTES.

Technical Instruction.—A Royal Commission, consisting of Mr. Bernard Samuelson, M.P., F.R.S., Mr. Henry Enfield Roscoe, D.C.L., F.R.S., Mr. Philip Magnus, Mr. John Slagg, M.P., Mr. Swire Smith, and Mr. William Woodall, M.P., has been appointed "to inquire into the instruction of the industrial classes of certain foreign countries in technical and other subjects, for the purpose of comparison with that of the corresponding classes in this country; and into the influence of such instruction on manufacturing and other industries at home and abroad." Three is to be a quorum. The Commission has the ordinary powers.

Agricultural Returns for 1881.—The Statistical and Commercial Department of the Board of Trade have issued a summary of the returns collected on the 4th of June last, which shows the extent of land in Great Britain under wheat to be 2,806,057 acres, or 103,381 acres less than in 1880; barley, 2,442,405 acres, or 25,036 acres less than in 1880; oats, 2,901,135 acres, or an increase of 104,230 acres; potatoes, 579,431 acres, an increase of 28,499 acres over 1880; and hops, 64,128 acres, or a decrease of 1,577 acres. The total number of live stock in Great Britain on the same day is given as—Cattle, 5,911,524; sheep and lambs, 24,582,154; pigs, 2,048,034.

Adelaide International Exhibition.—Particulars of this Exhibition, which was opened on July 31st, by the Governor, have been received. The Exhibition is reported to have proved highly successful, the demands for space having been so numerous, that it was found necessary to extend the original plan, and to greatly increase the area. The main building is that belonging to the Agricultural Society, to which have been added a number of important annexes, the principal of which contains sixteen courts. These are respectively devoted to Victoria, New South Wales, New Zealand, Tasmania, France, Germany, Austria, Italy, Belgium, Japan, Turkey, China, Switzerland, America, India, and Great Britain. The British Court occupies more than two-thirds of the east side of the annexe, with an area equal to six times that of any other. The miscellaneous exhibits comprise a fair representation of the varied industries of the United Kingdom. In honour of the opening, the House of Assembly adjourned. The Chief Justice, the President of the Legislative Council, the Speaker of the House of Assembly, the members of the Government, and the Mayor and Council of Adelaide, attended the ceremony.

Wool Exhbiition at the Crystal Palace.—The award of prizes by the Jurors of the Exhibition have been announced by the directors of the Crystal Palace. These consist of gold medals, offered by the Clothworkers' Company and Drapers' Company, and gold, silver, and bronze medals, offered by the Merchant Taylors' Company and others. The awards of the Jurors in yarns and chemicals will be announced shortly.

Education Code.—The proposals for the revision of the Code and Examination Schedules, dated 5th August, have been printed as a Parliamentary paper. The following particulars as to the mode by which these proposals were obtained were given by Mr. Mundella, the Vice-President, and are here quoted from a leading article in the *Morning Post*:—"In the first place we had memorials from School Boards and from persons connected with education who made suggestions for the improvement of the Code. We found ourselves able to agree on certain principles; and these papers were prepared by twenty or thirty of our principal inspectors, and we elicited from them the freest possible criticism. Having received these reports, we made a draft report, and agreed, further, that the matter should be thoroughly sifted, and the details worked out by a committee, consisting of Sir F. Sandford, Mr. Sykes, and Mr. Cumin, the three chiefs of the Department, together with Mr. Warburton, who had great experience as an inspector of smaller schools, Mr. Sharpe, as inspector of large schools, and Mr. Fitch, for his connection with training colleges." Over this committee Mr. Mundella presided. When its work was ended, it was yet further sifted, by being referred to an enlarged committee, including Mr. Matthew Arnold and three other inspectors. This was presided over by Earl Spencer, and the result is the document laid upon the table of the House.

Population of Austria.—The following is a summary of the population of the several provinces of the non-Hungarian portion of the Austrian Empire, extracted from the report of the Central Statistical Commission for taking the census last December:—Lower Austria, 2,329,021; Upper Austria, 760,879; Salzburg, 163,566; Styria, 1,212,367; Carinthia, 348,670; Carniola, 481,176; Trieste, Istria, &c., 650,532; Tyrol, 805,326; Vorarlberg, 107,364; Bohemia, 5,557,134; Moravia, 2,151,619; Silesia, 565,772; Galicia, 5,653,170; Bukovina, 560,599; Dalmatia, 474,489; total for the Austrian Crown Lands, 22,130,684. This gives a total increase for the eleven years of 1,734,054, or 8·5 per cent. This is a satisfactory result as compared with the Hungarian provinces, where the increase for the ten years—1870-1880—was only 1·24 per cent. The total population of the Austro-Hungarian Empire last December, was 37,739,407, being an increase for the decade of 1,925,450, to which the Hungarian provinces had contributed only 191,396. While the annual rate of increase in the provinces of the Austrian portion of the monarchy averaged only ·772 per cent., in Prussia it averaged during the last five years 1·179 per cent., being more than one-third higher. The population of the chief towns in the Austrian provinces last December stood thus:—Vienna, 726,105; Prague, 162,318; Trieste, 144,437; Lemberg, 110,250; Gratz, 97,726; Brünn, 82,655; Zara, 60,226; Czernowitz, 45,600; Linz, 41,687.

THE LIBRARY.

The following works have been presented to the Library:—

Portland Cement for Users, by Henry Faija, C.E. (London, Crosby Lockwood, and Co., 1881.) Presented by the Author.

Suggestions as to the Preparation of District Maps, and of Plans for Main Sewerage, Drainage, and Water Supply, by Robert Rawlinson, C.B. (London, 1878.) Presented by the Author.

Three Official Reports of Rigid Local Tests of the Perkins' System of Engines and Boilers. (London, Perkins' Engine Company, Limited.) Presented by Major Deane.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ART FURNITURE EXHIBITION.

The Exhibition of Works of Art Applied to Furniture, in connection with the Exhibition of Fine Arts at the Royal Albert Hall, will be closed on Saturday, the 10th inst.

The report of the Judges appointed by the Council, to recommend the awards of silver and bronze medals to the designers and art workmen whose work is exhibited in the Exhibition, has been received, and will be laid before the Council at their first meeting after the recess. The report is signed by Messrs. George Godwin, F.R.S.; Montague Guest, M.P.; Edward J. Poynter, R.A.; and Alan S. Cole, hon. sec.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE ART OF LACE-MAKING.

By Alan S. Cole.

LECTURE I.—DELIVERED MONDAY, APRIL 4, 1881.

Introduction. Early forms of twisted, plaited, and looped threads. Ornamental borders of costumes. Sumptuary laws. Venetian books of patterns for embroidery and lace. Flanders a centre of linen trade of Europe. Spanish and French importations of early lace. Effect of production of machine-made lace upon production of hand-made lace.

I. In undertaking to deliver a course of Cantor lectures upon "The Art of Lace-making," in compliance with a gratifying invitation from the Council of the Society of Arts, I am sensible of the responsibility I incur. I cannot, however, hesitate to claim your indulgence, since the position of lecturer is new to me. An experienced and able lecturer knows at once how to engage the sympathy of his audience. He leads them over difficult ground, making the difficulties interesting, just as a good guide does, who shows you the way up a mountain, through forest and rocky lands, across crevasses, and over snow fields. The tracing of a history of lace-making is not, however, likely to be beset with many difficulties. It covers a considerable space of time—over three hundred years—and involves the consideration, as all history does, of a number of circumstances. A tolerably straight course must, if possible, be adhered to, so that we may not stray off into tempting by-paths. Many works have been written and published upon lace-making, and I can hardly hope to bring to light many facts or reflections which have not been previously placed before the public. If I am successful in adding anything which may assist a true view of the development of lace-making I shall be fortunate.

II. Every one present, I presume, knows what lace is, in the ordinary and modern sense of the word. The shop-windows of linendrapers are filled with it. It is universally worn. About twice a week we may read in our newspapers that the lace trade is full of activity at Nottingham, in Belgium, in France, and elsewhere. If we go abroad, we see lace much like that we have left at home. Sometimes the lace trade is reported to be less vigorous than it was, sometimes it is more. A fair demand is maintained for Coraline and Vermicelli laces, whilst Bobbin, Bretonne, and Mechlin sell pretty well at "late" prices. The market, however, is dull on the whole, and there is no business in Valenciennes. This sort of intelligence usually comes to us at breakfast time, but it is not of the exciting character of some news which spoils our meal. After breakfast, if we happen to have absorbed the intelligence about the lace market, we may go out expecting to find symptoms of it in the shops. Not at all, however. A constant supply of cheap laces is to be purchased.

III. Now, I think that it would take some of us by surprise were an announcement to be made that Parliament had passed a Bill ordering that no lace wider than two inches was henceforth to be worn. What a disturbance this would create amongst lace workers and lace wearers! It would be almost more exciting than many recent points of domestic news. Judging from past events in similar circumstances, the ingenuity of people would be sharpened into all sorts of evasions of the law, both numerous and humorous.

IV. In the 14th, 15th, and 16th centuries, laws regulating costume were in force, and a result of them has been a number of entertaining anecdotes about evasions of them—smuggling, and so forth. An incident in the history of these laws was the imperturbability with which fashion displayed itself to be stronger than the laws. In spite of regulations and edicts, which one might suppose would have prevented people from teaching one another their fashions, and from interchanging their national productions and manufactures, this teaching and interchanging went on generally in an overt way, but still persistently forming and virtually ruling what is called fashion. At the outset of lace-making, difficulties like those just mentioned were imposed upon its development. Nevertheless, fashion has stimulated lace-making, and has raised lace work to an eminence in public favour, the hold upon which modern machinery is certainly striving to perpetuate, by widely disseminating lace of a special class.

V. The plan which I have adopted for my lectures is, roughly, as follows:—First, I propose to make a few observations upon the ability to twist, plait,

and loop threads together, upon the invention of patterns, upon the result which ensued when the twisting and plaiting were rendered subject to the pattern, and upon incidents connected with the development of this subjection of handicraft to design. Secondly, I propose to describe the features of specimens in the two chief divisions of hand-made lace; and thirdly, to touch upon the present condition of lace-making by hand, and the history of lace-making by machinery.

VI. When one wishes to make the acquaintance of a person, one generally desires to see her or him face to face, and to interchange ideas by conversation, and so forth. Probably what others have said has given us this wish. This was my case as regards lace. I heard a good deal about lace when I had the honour of serving on a committee which was formed to promote an Exhibition of Ancient Lace for the International Exhibition at South Kensington, in 1874. But when I came to be presented to some of the most splendid productions of the art, I found that hearsay did not give me much assistance in making myself really acquainted with these works. It was necessary to do more than express satisfaction at a beautiful piece of work, or to allow oneself to be carried away with enthusiasm over the interesting fact that some Venetian Dogeress had actually made a certain length of vandykes. Throughout the collection shown at the Exhibition there was an immense variety of pattern and of workmanship. It seemed to me that I should be more likely to understand this if I applied myself to a careful examination of a few of the important specimens. Accordingly, a pocket magnifying-glass became a necessity, and through its help I began to arrive at some sort of classification of laces by stitches. As soon as I had satisfied myself as to the marked difference between needle-made and pillow-made lace, I began to study the catalogue and the descriptions printed in it. I confess to having been surprised, and inclined to doubt my eyesight, at the frequency with which my opinion clashed with the descriptions. It seemed as though tradition was more often than not exactly the reverse of personal experience. Some of the best traditions were only credible, subject to important "if's;" others, however, seemed to gain in historic value as they harmonised themselves with results of actual observations. A sense of gratitude to the spirit which moved me to closely examine specimens, and not to rely too much upon traditions and so-called authentic records, required me to give you this little account of my experience in studying lace.

VII. From examining lace-work, with all the minute twistings, plaitings, and loopings of fine thread, and with all the variety of patterns so rendered, one is naturally led to think of the workwoman or man, under whose skilful fingers such extraordinary works have grown. What were the materials and implements used? and to what purposes has the work been put?

VIII. A first element in lace-making is the human ability to twist, plait, and loop thread together. In restricting my remarks to this human ability, I think one should not assign an absolute originality to man in his craft of making elaborate patterns in delicate materials. The amazing domiciles and structures—homes without hands, as the Rev. J. G. Wood calls them in his admirable book on the subject—made by many kinds of creatures, like moles, foxes, squirrels, birds, crabs, snails, beetles, ants, spiders, and bees, at once suggest varied forms of patterns, some of which are produced by plaitings and twistings. The marvellous, mathematical regularity of the hexagons in the bees' honeycomb, the radiations within polygonal shapes of the spider's web, the beautiful patterns of snow crystals, are all evidences of occult powers to design what we may call ornament; and the mere mention of them opens up an inexhaustible field of study, which would carry us far from lace-making. Even human skill in stitching—so notable a feature in some sorts of lace-making—has a prototype in the sewing done by tailor birds. I cannot resist the temptation of quoting a passage from Dr. Wood's book, which tells us how the tailor bird makes its hanging nest:—

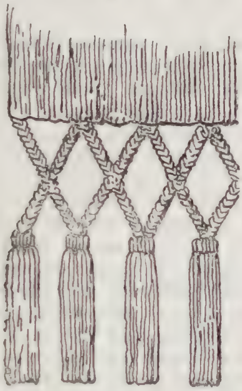
"The bird chooses a convenient leaf, generally one which hangs at the end of a slender twig; it pierces a row of holes along the edge, using its beak in the same manner that a shoemaker uses his awl, the two instruments being very similar to each other in shape, though not in material. These holes are not at all regular, and in some cases there are so many of them that the bird seems to have found some special gratification in making them just as a boy who has a new knife makes havoc on every piece of wood he can obtain. When the holes are completed, the bird next procures its thread, which is a long fibre from some plant, generally much longer than is needed for the task which it performs. Having found its thread, the feathered tailor begins to pass it through the holes, drawing the sides of the leaf towards each other, so as to form a kind of hollow cone, the point downwards. Sometimes a single leaf is used for this purpose, but whenever the bird cannot find one that is sufficiently large, it sews two together, or even fetches another leaf and fastens it with the fibre."

IX. You will, I hope, pardon me for this digression from the point we were considering, namely, man's ability in twisting and plaiting threads. I think we may take it that this ability is hardly a sort of spontaneous invention. It appears to be the development of certain natural functions of the fingers. Therefore, where there are hands and fingers, and a governing intelligence, the ability to plait, twist, and loop threads can display itself. One might not expect to find that the ability is restricted to one nation, or to one period of the world's history. Still, certain conditions, no doubt, especially favour the exhibition of this twisting and plaiting ability, and perhaps chief amongst such conditions is the existence in marked quantities of articles like flax or silk, and fibres of all kinds.

X. The Egyptian sculptures of Beni Hassan, as described by Sir Gardner Wilkinson, furnish us with a record, perhaps 2,500 years before Christ, of all sorts of employment, of customs social and domestic, in Egypt. Upon these Beni Hassan sculptures we have pictorial descriptions of how flax was beaten, the striking of flax after it is made into yarn, twisting the yarn into rope, weaving the yarn into a cloth by a loom, and hundreds of similar interesting details in the practice of arts by dexterous handicraftsman. At the British Museum is an Egyptian chair with a seat of plaited cords.

Fine threads of twine are stretched in parallel lines at about half an inch from each other, from back to front of the frame of the seat. Similar threads are also stretched from side to side. Thus a simple square meshed foundation is made. Upon it are intertwisted—diagonally across the meshes—rows of some eight or twelve strings or cords, and so the seat, not unlike our modern cane seats, is constructed. This sort of plaiting and intertwisting, however, cannot be said to have decorative pretence, and is not so germane to ornamental work we call lace, as are fringed borders of the robes sculptured upon Assyrian monoliths, of the time of Assur-nazir-Pal, about 800 B.C. (See Fig. 1.) The lines forming a trellis pattern in

Fig. 1.



Assyrian border, 800 B.C.

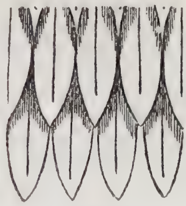
the upper part of these borders appear to consist of round, plaited cords, very similar in their plaiting to that which we see upon fringed borders of Persian carpets now in the market, or to plaited leather whip thongs. On the mantle of the king, the trellis pattern is rather more elaborate than those on the dresses of the attendants. The design is, however, quite primitive.

XI. In our English Bible lace is frequently mentioned, but its meaning must be qualified by the reserve due to the use of such a word in James I.'s time. It is pretty evident that the translators used it to indicate a small cord, since lace for decoration would be more commonly known at that time as "purls," "points," or "cut works."

XII. Of lace amongst the Greeks we seem to have no evidence. Upon the well-known red and black vases are all kinds of figures, clad in costumes which are bordered with ornamental patterns, but these were painted upon, woven into, or embroidered upon the fabric. They were not lace. Many centuries elapsed before a marked and elaborately ornamental character infused itself into twisted, plaited, or looped thread work. During such a period the fashion of ornamenting borders of costume and hangings existed and underwent a few phases: as, for instance, in the Elgin marbles, where crimped edges appear along the loose flowing Grecian dresses.

XIII. It is recorded that our "general parents" in the Garden of Eden, wore aprons of leaves, overlapping one another, an arrangement subsequently modified for their scale armour by Greeks and Romans. (See Fig. 2.) The scales of

Fig. 2.



Overlapping leaves of armour.

the armour were of leaf and billet forms, as were the edges of the under skirt and sleeves. (See

Fig. 3.

Overlapping scales of armour.

Fig. 3.) If you want to see an attractive example of this method of varying the line of the edge, the costume of Mr. Irving, as *Synorix*, in Mr. Tennyson's drama of "The Cup," presents you with one. Along the borders of Mediæval costume, this custom of indenting the border was perpetuated. (See Fig. 4.) The French word, "dentelle," is

Fig. 4.

Cut, scalloped edge.

evidently derived from the tooth-shape of such scallops.

XIV. To continue, however, our rapid glimpse of fashion in patterns for bordering costumes and in decorative accessories to dress, which seems to have led up to lace. Mosaics, dating from the 6th century after Christ, preserved in churches at Ravenna, give us representations of early Christian saints, Cecilia, Crispina, Lucia, and others, attached to whose white head-dresses are fringes. Besides these, there are resplendent mosaics of the Empress Theodora and her ladies in waiting, all arrayed in sumptuous apparel, some of which is ornamented with dentations, and others with wavy and undulating borders. In 1078, Benedetto Antelami, recording the fashion of his time, wrought a patterned edging to the robe of the Virgin, who appears in a composition he carved in stone for an altar or panel at Parma. A border, consisting of a series of holes, no doubt cut and worked upon

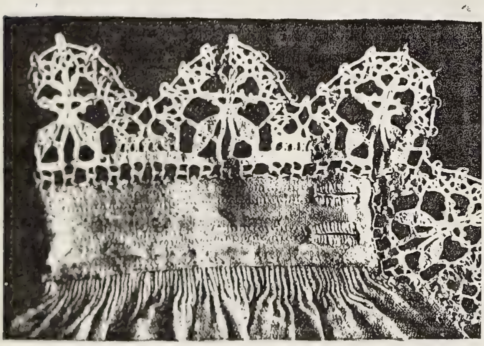
the vestments of figures sculptured by Nicolo Pisa, brings us to the year 1260, and seems to lead us a little nearer to ornamental open work which might be considered to be lace. Somewhat later, we have a repetition of this sort of border treatment in figures sculptured by Tino da Camiano. At Florence, in San Michele, Orcagna has decorated the costumes of figures carved in his splendid shrine. Fifty years later, Ghiberti indulged his decorative fancy in a similar way, as is shown in the panels of figure subjects which adorn his doors of the Florence Baptistery. In 1447, various art workmen engaged in sculpturing the temple erected at Rimini, to the glorification of the Malatesta family, decorated the borders of the robes of the figures. But in mentioning these Italian instances of the fashion in borders of dresses, it must not be supposed that similar fashions had not also penetrated to other European countries.

XV. In Edward IV.'s time, in England,

> "Cut werke was greate in Court and towns,
> Both in men's hoddes and also in their gowns."

but this "cut werke" is not cut work embroidery as we know it. It was the cutting out into shapes, the dentation or scalloping of the borders of stuff "hoddes" and gowns, as we find it with the Romans. (See Fig. 4.) This kind of ornamentation undoubtedly influenced the shapes in which most of the first laces were to be inserted, and we trace such shapes in "points" of the 16th century, an example of which I will show you (Fig. 5). Chaucer, too, in his Parson's tale,

FIG. 5.



Cuff trimmed with lace-work in "points," or Vandykes. Late 16th century.

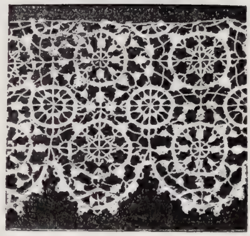
gives us an insight into fashions of dress, when he deprecates "the superfluitee of clothing, which maketh it so dere to the harme of peple, not only the cost of embrouding, the disguising, endenting or barring, ounding, palming, winding or bending, and semblable wast of cloth in vanitee," but also of much else that need not, perhaps, be quoted. Both Flemish and Italian painters, the Van Eycks, the Bellinis, and Carpaccios, supply us with rich representations of gold thread and jewelled fringings worn by the wealthy. Besides these we find that the small linen collars and cuffs of the period were ornamented with some simple and delicate embroidery in black and red silks. Borders of small plaited loops or "purls" were frequently fastened along the edges of these linen collars and cuffs, but as late as the end of the 15th century there is no marked display of ornamental open work done in white threads.

XVI. We may now glance at the use of white thread materials like linen, &c., about this time. Northern countries of Central Europe were foremost in the cultivation and employment of flax. Flanders was especially notable in this respect. Holland gave its name to the flax cloth woven in the Middle Ages, and much used in Europe. The town of Cambray gave its name to cambric; and from "d'Ypres" we are supposed to derive diaper, just as damask comes from Damascus, sarcenet from the Saracens, and baudekin from Bagdad. In the 14th and 16th centuries the Venetian Republic was in the glory of the commercial relations with all European countries; she was virtually one of the most prosperous and artistic of European centres. Her "argosies" and "Flanders galleys" were well-known above all other trading vessels on the coast line of Western and Northern Europe. The name "Flanders galleys" marks in a way the considerable commerce Venice had with Flanders. These galleys used to lie along the quays of the delightful old town of Bruges, and there discharge their cargoes. However much during four hundred years the mercantile prestige of Bruges may have declined, there are now signs that the use of the old town as a Belgian Liverpool is being considered. But during all this Northern trafficking four hundred years ago, much trade with Oriental countries was carried on. The wealth and taste of Venice attracted riches and luxuries of costumes, silks, gold and silver clothes, velvets, and much else from the East. An extravagant indulgence of wealthy Venetians in their use of these costly materials stirred the Council of the Republic to pass sumptuary laws from time to time, prohibiting or limiting the use of such things. Venice, however, must not be understood to have been singular in this respect, for similar laws were in force in other countries. These laws, principally aimed at vanity, were, in the circumstances of the times, not without influence in educing artistic ingenuity. And I think that in regard especially to lace-making at Venice, they have an important bearing. A writer of the 17th century, describing Venice, speaks of a pre-eminence that Venetian ladies, among Italian women, enjoyed for the whiteness and fineness of their linen, as well as for their skill in sewing and embroidering. An old Venetian proverb runs, "La camicia preme assai piu del giubbone," or "The shirt before the coat." Now, since the rich coloured decorations used by Venetians in their costumes were, to a considerable extent, placed under the ban of sumptuary edicts, the idea of elaborating ornamentation for their far-famed white linen seems to have arisen. The seeming modesty and economy of such white thread-work, to be adopted as a successor to the gorgeous gold fringes and fine coloured embroideries was, I think, an ingenious but perfectly logical recommendation which helped to give life to this new fancy of fashion. Besides giving the regular embroiderers in Venice a new diversion for their talents, this white thread-work commended itself to the peasant spinners of thread wherever they might be, whether in Italian hills or lower lying lands of Flanders. Spinning from off the distaff has

always been a favourite occupation with women in many countries of Europe. The making of simple twisted and plaited white thread edgings to collars and cuffs could be readily taken up by the thread spinners. A new occupation was thus provided, which could be followed by peasants in their homes and out of doors, or by sailors in their leisure time on boardship. In convents, too, where a gentle art like embroidering has always found favour, the taste for white thread and linen ornamentation infused itself. Embroidering linen became so fashionable that designers compiled and published books of patterns, which, as a rule, were dedicated in high-flown, courteous language of the time to "le belle donne," who were addressed by the various compilers in their dissertations on the subject as their gentle, delicate, and magnanimous, and most beautiful readers.

XVII. Two or three antiquaries have paid close attention to the history of these pattern-books. Some claim the honour of first publication for France, others for Italy, and others for Germany. The fashion of pattern-books came to England as well. On looking over many of these rare books (of which, by the way, Signor Oncagnia, of Venice, has recently published some admirable reproductions in *fac-simile*), I find that with none of them are practical directions supplied of how the different sorts of works, for which there are patterns, are to be executed. It is agreed, I think, that of the pattern-books that by Alessandro Pagannino, dated Venice, 1527, is one of the earliest. It is entitled a "First Book of Embroidery," as well as for instructing "oneself in diverse methods, uses, and ways of embroidery never before attempted or published, the which methods the willing reader may teach himself." Putting aside the author's ascription to himself of the credit of having published the "first" book on the subject, it is not unlikely that the embroidering of shirts, socks, cuffs, and gloves was in vogue before the book appeared. Be this as it may, neither patterns nor titles indicate lace work. In a book by Tagliente, published in 1531, we find an enumeration of stitches, such as "punto a filo" (perhaps a darning stitch), "punto sopra punto" (cross-stitch, perhaps), "punto ciprioto" (Cyprus stitch), "punto croceato" (perhaps a stitch done with a hooked needle, like crochet), "punto in aere" (which might be "punto in aria," or needle-point lace) "punto fa su la rete" (which would be work done upon a species of canvas), "punto disfilato" (or drawn thread-work), and others. The title "punto in aere," or point in the air, should interest us particularly. But the pattern entitled "punto in aere" is not specially distinguished as a lace pattern; with the exception of this doubtful "punto in aere," all the embroidery indicated is intended, as you have seen, to be done upon a foundation of stuff. The materials named to be used are silks of various colours, gold and silver threads, and other sorts of threads; whilst amongst the implements depicted are compasses, pens, pencils, scissors, a pad for pouncing pricked designs, hanks of threads, but there are no bobbins, pins, cushions. The designs are to be worked for costumes and hangings, and besides those I have shown, consist of scrolls, arabesques, birds, animals, flowers, foliage, herbs, and grasses; in fact, so far as lace would be concerned, involve the execution of work as none but practised lace makers would be able to overcome. Twenty years later we have special geometric patterns workable by lace makers, who were at the threshold, so to speak, of the practice of their art. (See Fig. 6.)

FIG. 6.



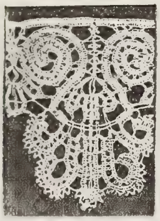
Part of a border of needle-point lace, geometric design. About 1550.

At this time, about 1550, the "punto gropposi" (knotted work) is named. The designs, too, of the same time, for "punto in aria," are clearly geometric lace designs.

XVIII. Monsieur Aubry, member of the jury appointed to make awards of prizes to lace manufacturers, who exhibited specimens at the Great Exhibition in 1851, is one of the first of modern writers on the art of lace-making. For the groundwork of her "History of Lace," I find that the late Mrs. Bury Palliser, as all students of this subject must be, is indebted to him. M. Aubry says that Italy and Belgium dispute the honour of the invention of lace-making. Without attempting to settle the dispute, he says that we can easily imagine that the fabrication of lace in each of these countries was quite different, and thus having drawn upon our imagination, Mons. Aubry is assured enough to say that if Venice is the cradle of needle-point laces, at Brussels it is certain that the first pillow and bobbin-made laces were produced. After examining the evidence, which he brings forward to support his statement, as well as considering remarks made by Mons. Seguin in his "History of Lace," I have formed the opinion that so distinctive a method of using threads as that involved in ornamental lace-making has not a contemporary double origin; and in a later lecture I hope to show you a series of specimens which appear to indicate how elaboration of plaiting, twisting, and looping white threads developed according to the demands made upon workmen's ingenuity by the designers of patterns. The workmen's ingenuity developed two distinct classes of work, the one needle-point lace, the other pillow-made lace. The former is, undoubtedly, an offspring of embroidery, just as the latter is of fringes or twisted cords. Both, however, in respect of artistic pretence, are traceable to the pattern-books. We have noticed the appearance of "punto in aria" or needle-point lace, and that of "punto gropposi" or knotted work. A modification of the "punto gropposi" is the "merletti a piombini." (See Fig. 7, p. 774). In this specimen you would see that plaiting is used. There are no knottings, and few simple twistings. The first patterns for both plaiting and needle-point work then appear to have been made in

Venice in the 16th century, say about 1560, and thus M. Aubry's supposed double origin of lace vanishes, that is, if my statement be correct.

Fig. 7.



Plaited and twisted thread-work known as "Merletti a Piombini." About 1560.

XIX. No sooner, however, are novelties produced, than imitations quickly follow. The twisted and plaited thread-work was by some more easily done than needle-point work by others; and the Flemish, the chief spinners and weavers of thread, very naturally I think, were the first imitators of Venetian patterns of this sort of work, which was plaited on cushions. We have already seen that commercial relations long existed between Venice and Flanders. It had been chiefly carried on by ships, and this, of course, in respect of heavier merchandise, but in the 15th and 16th centuries an overland route *via* Augsburg, Cologne, and Bruges, was also used, probably for lighter wares. Copies of pattern-books, and dentated and scalloped trimmings, were no doubt included amongst these lighter wares. It is not, therefore, surprising to find pattern-books, evident imitations of Venetian books, springing into publication along the route overland. At Augsburg and Cologne, and as far north as Antwerp, we know such books were issued. At this last-named city, possibly about 1540, one of the first of the foreign imitations of Venetian books of patterns was produced. It is called "A New Treatise; as concerning the excellency of Needlework, Spanish Stitch, Weaving in the Frame, very necessary to all who desire perfect knowledge of Seamstry, Quilting, and Broidering work, containing 138 plates."

XX. The mention of "Spanish stitch" makes one almost expect to find Spanish books on needlework. But, curiously enough, no such books corresponding to the Italian, German, Flemish, French, and English pattern-books have been found or known to have been published in Spain. Spanish stitch is now supposed to have been a black silk embroidery upon linen, and its use is assigned to the early 17th century. This is not a lace, however. Of the supposed manufacture of artistic lace in Spain, it may be convenient for me now to speak. It will, no doubt, be a matter of surprise to many, who are so accustomed to hear of and see what they are told in "Spanish point," if I say that Spain cannot be identified with the making of ornamental and fine white thread lace, as are Italy, Flanders, and France. Señor Riaño, an authority in these matters, writes that, "The most important ordinances relating to Spanish industries are those published at Toledo and Seville in the 15th and 16th centuries, and at Granada in the 16th and 17th centuries, and in none of them do we find lace even alluded to." A Friar, Marcos Antonio de Campos, 1592, preaches, "I will not be silent and fail to mention the time lost these last years in the manufacture of 'cadenetas,' a work of thread, combined with silver; this extravagance and excess reached such a point, that hundreds and thousands of ducats were spent in this work, which, besides destroying the eyesight, wasting away the lives, and rendering consumptive the women who worked it, and preventing them from spending their time with more advantage to their souls, a few ounces of thread and years of time were wasted with so unsatisfactory a result." Señor Riaño seems to argue from this that the Friar adopted "cadenetas" as a term meaning lace-work. But, further on, he says "cadenetas" is chain stitch. Bearing in mind that the fashion of the 16th century directed itsself towards "points," and "dentelles," and bands of insertion of lace-work, it might seem perhaps more likely that the Friar would have consumed such adornments with the fire of his wrath —naming them by their proper names—like "puntas," "randa," and "entredos." The Friar may, no doubt, have been inveighing against a sinful extravagance in the use of some sort of embroidery; I do not think, however, that we can safely rely upon what would be a misapplied term, as proof that Spain made lace; that she embroidered is well-known. Whilst the female portion of his family embroidered, Cervantes, it is said, wrote much of his "Don Quixote."

XXI. Ornaments made of plaited and twisted gold and silver threads, much in the way that some lace was made, were produced in Spain during the 17th century. Mention of those is to be found in the ordinances of that time. Towards the end of the century, Narciso Felin, author of a work published in Barcelona, quoted by M. Aubry, writes, that "edgings of all sorts of gold, silver, silk, thread, and aloe fibres are made at Barcelona with greater perfection than in Flanders." In the 16th century Flanders was part of the Spanish dominions. She is then always spoken of as Spanish Flanders. To her, Spain was indebted for a quantity of manufactured and artistic goods, linen and lace included. I conclude, therefore, that the Barcelona lace-making was more or less an imitation of that which had pre-existed in Spanish Flanders. Apart from this, the gold and silver lace of Cyprus, Venice, Lucca, and Genoa, preceded that from Flanders. It appears to me that Spain was later in the field of artistic lace-making than Italy, Flanders, and France. As a great commercial and wealthy power, Spain, I think, in the 16th and 17th centuries, imported the greater portion of the fantastic and fashionable luxuries she required. Even the celebrity of the gold "Point d'Espagne" is due, I fancy, more to the use of gold lace by Spanish grandees, than to the production in Spain of a gold lace, better in design, in workmanship, and quality, than that from Italy and France. The manufactories at Paris and Lyons were in full force, supplying the fashionable world with gold lace in the 17th century. The name "Point d'Espagne" was, I think, a commercial name given to gold lace by French makers. It is interesting to note that Beckmann in his "History of Inventions," says that it was a fashion to give the name of Spanish to all kinds of novelties

such as Spanish flies, Spanish wax, Spanish green, Spanish grass, Spanish seed, and others. This in a measure establishes the value set upon the qualification or title "Spanish," and, at least, indicates that the custom of Spaniards was much courted by other nations. In concluding these observations as to claims that Spain may have for being considered an early maker of artistic lace, I may quote the following passage from Señor Riaño, which greatly affects the value of what would otherwise be a fact of importance contained in Mrs. Palliser's "History of Lace":—

"Notwithstanding the opinion of so competent an authority as Mrs. Palliser, I doubt the statement, finding no evidence to support it, that thread lace of a very fine or artistic kind was ever made in Spain or exported as an article of commerce during early times. The lace alb, which Mrs. Palliser mentions to prove this, as existing at Granada, a gift of Ferdinand and Isabella in the 15th century, is of Flemish lace of the 17th century."

XXII. Of France and her connection with early lace-making, there is not much at present to be said. It is evident that a great deal of foreign lace, chiefly from Flanders and Venice, were imported into France, and that all sorts of prohibitions were issued to prevent the expenditure of the French upon foreign goods, and so, if possible, to encourage the manufacturers to make articles for home consumption; but the importations went on, and France was at this time unable to make laces to compete with those from Italy and Flanders. The compilers of commercial dictionaries and encyclopædias, Diderot, Savary, Roland de la Platiere, and others, writing in the 18th century, give the names of insignificant little primitive twistings and plaitings like "gueuse" "mignonette," and "campane." These bear about as much relation to fine artistic laces as a flint instrument does to a Cellini's sword-handle. Taste in manufacturing lace in France was not evoked until Frederic Vinciolo came to Paris about the end of the 16th century, and supplied the Court of Henry IV. with varieties of white thread work, including the geometric points of Venice. But even Vinciolo's nfluence was limited, and only laid the seeds of a condition of taste in France, which enabled Colbert forty years later to induce Venetian lace designers and workmen to come over to France and to help in the establishment of a number of places where lace should be regularly made. Many of the towns nearest to Flanders were judiciously chosen for these new lace establishments. But the chief of the French towns subsequently most famous of all for its lace was Alençon in Normandy. Of the influence of Alençon we shall hear more in the course of our investigations of needle-point lace making.

XXIII. Of incidents concerning workpeople engaged in the manufacture of lace, we have little precise information. History is almost silent in respect of guilds, or bodies of lacemakers (if there were such) in the 16th century. Venetian archives might be expected to reveal some light upon this; but at present the search has not been very fruitful. Documents exist to show that a noble lady, Bianca Capello, was able to monopolise the making of certain laces for her own use, in 1578; and that in 1582 Juan Isepo worked a splendid collar, very likely of Reticella work, for Maria Morosoni di Francesco. A note is given in a pamphlet by Signor G. M. de Gheltof, of the foundation of a school of 120 lacemakers at Venice, by Morosina Morosini, in the 17th century.

XXIV. Valuable State records, from which some information might probably have been obtained about the Flemish lace trade, were burnt in a fire at Brussels in the year 1731. Private papers of nunneries in Italy and Flanders would probably be an interesting source to examine. Evidence, such as it is, points to lace-making having been at first an occupation of individual peasants, rather than of organised bodies of persons. Nuns in convents no doubt produced a good deal of lace, as well as children in schools; and by Italian trimming makers and French guilds of "passementiers," probably much lace of a primitive kind was made. Lace of later periods, that is, from the middle of the 17th century onwards, can generally be identified with centres of manufacture, like Valenciennes, Mechlin, Brussels, Alençon, Honiton, &c. But of the earlier laces, excepting those done according to Venetian patterns, we have not much to rely upon for guidance.

XXV. The 16th century Italian patterns are sometimes named "punto Famenghi," "punto Genovese," and "punto Francesco;" but there is little variety in the style of the patterns, so that the names, even if they meant more than the celebrated "Point d'Espagne," do not give us new clues as to other centres of manufacture if they existed. These names were apparently pattern-makers' names for styles, intended to catch the fancy of the different people to whom they were dedicated, and may have been made in various towns in Italy, such as Rome, Venice, Genoa, Milan, Piacenza, and elsewhere. I am afraid, therefore, that much of the classification of early lace has to be somewhat vague.

XXVI. An elaborate design, for instance, is hardly likely to have been worked out by humbly trained peasant hands; it is more likely to have emanated from some place where workmen and women were employed for the purpose of lace-making, and where they had access to good patterns, plenty of materials, and so forth. Such conditions existed probably also in Italian and Flemish convents. On the other hand, simple patterns would, from the ease with which they could be executed, recommend themselves to makers of the less important laces, whose operations would have a tendency to become restricted to the repetition or modification of such simple designs, the sale of which would no doubt take place amongst the villagers, or else be promoted by some *Autolycus*, and such hawkers of wares, at fairs and markets.

XXVII. The excellence of much of the early lace is perhaps due in a great degree to the good taste of the wealthy, who bought and wore the work. Demand ruled supply, whereas now-a-days, supply seems to rule demand so far as beauty of design and quality of workmanship goes. There are few Mecænases now. The recommendation of the salesman is a chief moulder of public taste. The salesmen in turn regulate the style and quality of the goods to be made, according to their opinion of public taste and fashion. Such relations do not seem to have existed when the great Alençon factories were established. For the

wealthy lace wearers, then, at that time, the number of lace workers was insignificant as compared with the number now. One might say that lace wearers could be counted by the thousand, whilst those not wearing laces were the millions. This is now almost reversed. The millions now wear it, or something like it. Louis XIV. and Colbert determined that French taste in lace should be good, and virtually took into their own hands the supply of lace to the country. From Alençon were sent out admirable patterns and exquisite workmanship, which were readily accepted by lace fanciers. Brussels unquestionably adopted styles of Alençon designs for her pillow laces, which in time superseded French needle-point laces. Our English pillow-lace workers adopted some of the Brussels patterns and some of the Mechlin; but English taste was easily gratified by less skilfully arranged patterns, and found sufficient pleasure in the peasant laces of Buckinghamshire and Devonshire. It is these patterns that a good deal of the machine-made lace imitates, though within the last three or four years there has been a marked phase of other more ambitious imitation in the machine-lace trade. Something akin to the rich patterns of ancient hand-made lace is now made by the machine, and to the majority this substitution of machine-made for hand-made goods is satisfactory. As a rule the difference between machine and hand-made lace is not detected by the many. If there is a difference, to some it is that machine-made lace, from some points of view, is the more wonderful and more to be prized of the two sorts of work. Setting aside any prejudices one may have, and reviewing the variety of forms wrought years ago, we may consider some of the circumstances of the production of laces. Sometimes laces were made in dim and dark cellars, so that the soft fragile threads should retain their elasticity, and not become brittle. A ray of light alone was allowed to fall upon the workwoman's cushion. What an expense of eyesight and health must then have taken place. Compare truly costly works produced in such circumstances, with the low-priced repetitions done in taut wiry cotton threads which grow with precise monotony of pattern in the bustle and clatter of machinery, at the expense of iron and steam, and one is perhaps inclined to be glad at the release of human labour from penalties like those which formerly accompanied lace-making. I do not think anyone can well say what may succeed to the mechanically devised and produced materials now called lace? They seem to satisfy present demand and to reflect the taste and ability of the age. Is it vain to hope for a revival of hand-made works? Is the time to arrive when machinery shall have exhausted itself in its endeavours to infuse into its productions the quality of hand-work—or has a period commenced when people shall be contented with mechanical instead of manual art? and so from this possibly pass on to a condition of indifference to fine artistic works of handicraft, which not many years since were reported to have been pronounced by a philosopher and leader of opinion to be but the rubbish of human labour.

XXVIII. In my next lecture I hope to deal with the various needle-point laces, and besides the examples shown on the screen there will be a few fine specimens of lace, and some photographs. I must not conclude my remarks this evening without acknowledging the advantage I think both you and I have received from Sir Philip Cunliffe-Owen, director of the South Kensington Museum, who kindly caused many of the transparencies of lace to be made, as well as from Sir William Drake and Mr. Edmund Dresden, who lent specimens, some of which have been exhibited, and others photographed, by Sergeant Jackson, R.E., the able assistant of my friend, Captain Abney, R.E., F.R.S.

MISCELLANEOUS.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The fourth general report, dated Easter, 1881, has just been issued, and the following is an abstract of its contents :—

The Committee of Management have the honour to submit, for the informati on of the founders of scholarships and subscribers generally, the following report on the condition and proceedings of the school during the past year.

Scholars and Private Students.—The body of scholars has undergone some slight changes during the year; *e.g.* seven scholars have resigned their scholarships, viz., four to devote themselves entirely to their profession, one in order to prosecute his studies in Italy, one from failing health, and one has forfeited her scholarship by irregularity of attendance, and by failure to comply with the rules of the school. Three of these vacated scholarships have been conferred on new scholars, one of them has been cancelled by the founders for want of means to continue it, and three are still vacant.

The number of scholarships is now, therefore, 92, of which 23 are held by males, 66 by females, and three, as has been already said, are vacant.

Arrangements having been made for the admission of private students for periods of not less than one year, on payment of £40 a year in advance, there have been admitted of that class during the year now ended ten females and four males. Such students are entitled to the same privileges, are taught by the same Professors in the same classes, and are subject to the same discipline as the scholars. Previous to admissiou their musical abilities are tested by examination.

Attendance, Conduct, and Studies.—The attendance of the scholars, save in cases of sickness, continues to be regular and punctual; and their general behaviour is very satisfactory. The instruments and subjects of study are, of course, substantially the same as they were at the time of the issue of the last report. At present 57 students are cultivating the piano as their principal subject of study; 32, singing; 14, the violin; five, the organ; and one, the flute. The pianists take singing, violin, organ, clarionet, or violoncello, for their second studies; while the vocalists, violinists, and organists, are compelled to study the piano. All the students continue to attend the harmony and choral classes, the vocalists attend the Italian classes, and all those who are competent for it have instruction in counterpoint and composition. An orchestral class has been established and placed under the direction of Mr. F. H. Cowen. It embraces all those students who play upon orchestral instruments, and meets for practice two hours per week. During certain terms there are

periodical concerts in which all the scholars in turn take part.

Terms of Study, and Examinations.—The period embraced by the present report includes three school terms, viz., the Midsummer and Christmas terms of 1880, and the Easter term of 1881. At the end of the Midsummer term the fourth annual examination of the students took place in the West Theatre of the Royal Albert Hall. The professional examiners included Sir Michael Costa, Sir Julius Benedict, Sir George Elvey, and Mr. Charles Hallé. Mr. Hullah and Professor Ella being too ill to attend, the Committee of Management, at the suggestion of Dr. Sullivan, the principal of the school, invited Messrs. Otto Goldschmidt and Henry Leslie to join the Board of Examiners, and these gentlemen courteously accepted the invitation. Owing to some unfortunate want of understanding between the authorities of the school and the examiners, the examination, though going on for two days, was not formally conducted; and in a report which the examiners made to H.R.H. the Prince of Wales, it was admitted that the examination which had been held was not an examination in the strict sense of the word, and neither fair nor advantageous to master or pupil. Under these circumstances it was arranged that another examination of a more strict, formal, and searching character should be held at the earliest convenience of the examiners.

The ordinary terminal examination for the Christmas term was held in the school on Saturday, Monday, and Tuesday, the 18th, 20th, and 21st days of December. It was conducted by Drs. Sullivan and Stainer, who had the assistance of the Board of Professors and of several other professors. It extended to the principal subjects of study, to modulation, sight reading, figured bass reading, playing from vocal score, playing from full score, and transposing song accompaniments. On this examination Dr. Stainer reports:—"The examination on this occasion was directed to a class of subjects in which the scholars had not been hitherto tested, namely, transposition at sight, playing from figured bass, from full score, &c. The results showed that a considerable amount of proficiency had been attained by the majority of students, although the novelty of the test caused so much nervousness, especially among the younger pupils, that the task of the examiners was not easy. In all examinations on these special subjects it will be found that players on polyphonic instruments such as the piano and organ, attain the highest standard, players on string instruments a less degree of proficiency, whilst vocalists rarely master them to any marked extent. In the examination of the principal studies of the scholars, the results were favourable. The signs of improvement in execution and taste, anxiously watched for by the examiners, were not deficient, although some few pupils proved that they never could rise above a medium standard of proficiency, owing to their want of natural talent.

Towards the end of the Easter term 1881, arrangements were made at the request of H.R.H. the Prince of Wales, for holding the examination which had been ordained by the committee of management at the termination of the examination held last Midsummer. The interest which the Prince of Wales felt in the school, as the suggested nucleus of the proposed Royal College of Music, led his Royal Highness to appoint a body of examiners himself, and to give them instructions for the formal discharge of their duties.

A full report, dated April 23, 1881, signed by Henry Leslie, Chairman; Julius Benedict, Knt.; Michael Costa, Knt.; W. G. Cusins; George J. Elvey, Knt., Mus. Doc.; Otto Goldschmidt; and John Hullah, LL.D., was presented to his Royal Highness.

Position and Prospects of the School.—The committee of management having been informed that the executive committee, acting with his Royal Highness the Prince of Wales on behalf of musical education in England, would not be in a position to take over the school, as part of the proposed Royal College of Music, at Easter, 1881, the period when the present scholarships expire, it was resolved at a meeting, held on the 13th November, 1880, that it was desirable to continue the school for one year pending the granting of the charter, and that application should be made to the founders of scholarships and other subscribers to renew their subscriptions for that period. In pursuance of this resolution, an appeal was issued by H.R.H. the Duke of Edinburgh, dated 29th February, 1881.

The appeal resulted in the renewal of sixty-three scholarships, the foundation of eight new ones, and the contribution of £510 10s. in new subscriptions. These resources, together with the balance in hand, amply suffice to keep the school going for another year; and the professors without exception having expressed their willingness to continue their respective services, the prospects of the school for the coming year are very satisfactory.

Donations and Loans.—Three framed engravings on musical subjects have been generously presented to the school by H.R.H. the Duke of Edinburgh. The corporation of the Albert Hall continue most munificently to permit the school to use one of their theatres for choral and orchestral practice and for examinations. The great firms of pianoforte manufacturers, Messrs. John Broadwood and Sons, Messrs. Chappell, Messrs. Collard, and Messrs. Kirkman, also still most liberally afford us the gratuitous use of their excellent pianofortes.

THE MICROPHONE IN OBSERVATORIES.

M. Van Rysselberghe's idea of using the microphone in observatories has been adopted in the Observatory at Geneva, and by the aid of the instrument, in combination with the telephone, the sound of the beats of the normal pendulum have been made audible in every part of the building. M. W. Meyer, assistant-astronomer at the Geneva Observatory, has given the following details in the *Archives des Sciences Physiques et Naturelles.* The microphone is fixed to the exterior of the framework in which the pendulum swings. One of the conducting wires connects one pole of an ordinary sized Meidenger cell with the microphone, whilst a second wire goes from the other pole of the battery through a telephone and commutator with three binding screws, to the microphone. The two wires coming from the coil of the telephone are very fine, and are interlaced so as to form one supple cable. By this means the telephone can be carried into any part of the Observatory, wherever required. Thus, it can be carried up to the top of the building and the course of the stars watched, whilst the observer listens to the number of beats of the pendulum. By means of a second telephone, with one wire fixed to the third binding screw of the commutator, the pendulum beats can be heard equally well in the lower rooms of the Observatory, as in the upper portion. The Observatory is also connected with the Hôtel Municipal, so that the beats of the electric clock regulator in that building can be heard in the Observatory and compared with the beats of the pendulum in the Observatory. At a certain hour the person whose duty it is to regulate the regulator in the Hôtel Municipal gives notice to the Observatory, by ringing a bell, that he is at his post. He then connects his telephone line, and the astronomer tells him how far the regulator is wrong; he puts it right, and re-establishes the microphonic communication, in order that the astronomer may test the regulator again by the pendulum. All this is done in about five or seven minutes. The apparatus is stated to have always worked well.

GENERAL NOTES.

Australian Fruit for England.—A writer, in a recent number of the *Colonies and India*, draws attention to the likelihood of our obtaining supplies of fruit from Australia. He remarks that "soft fruits" cannot satisfactorily stand the length of the passage and the heat of the tropics; but apples, pears, oranges, and walnuts, and even grapes, may fairly be expected to do so. A recent consignment of apples failed to realise a sufficient price to pay the freight; but the freight was unduly high, and the fruit arrived at a time when the market was glutted with Canadian produce. Several cases of grapes have been landed in excellent condition; and there would appear to be no reason, if care is given to the gathering and proper packing of the fruit, why grapes of the best quality should not be placed in Covent-garden towards the close of the winter, and compete favourably with our hothouse produce, whilst the best Tasmanian pears would not fail to lower the price of a guinea the half-dozen commonly asked for Jersey fruit in spring. Both grapes and pears would pay better than oranges, but the latter fruit will unquestionably stand the passage best. The packing of the fruit is the main point; but it must be carefully gathered when free from dew, and packed when not heated by the sun. The air should not be entirely excluded from the fruit, and the use of dry sea-weed is recommended for lining the cases; while if each pear, apple, or orange is separately wrapped in tissue paper its condition will be materially improved. These fruits should be packed ripe; but grapes may be left to mature on the passage. Tasmanian jams are now to be bought in London shops; and, with the fast steamers now running, many of them provided with ice chambers, there is no reason why a little care and experience should not result in Australian fruit being placed in the English market in sufficiently good condition to ensure a remunerative return to the exporter.

Indian Exhibition.—An Exhibition of the products of India is to be held in December of the present year, and continued during January, 1882.

Congress of Electricians at Paris.—The Chambre Syndicate d'Electricité has organised an international meeting of electricians to take place in Paris between the 1st and 15th of October. *La Révue Industrielle* says:—"The congress will treat of theoretical questions; the meeting will lend itself by preference to the purely industrial and commercial side of the question. It will study the ways and means necessary to enable electricity to take the place it merits in our advanced civilisation." The president of the Chambre Syndicate d'Electricité is M. H. Fontaine, and the president of the organisation committee is M. Armengaud, jun., to whom all papers, &c., intended to be communicated at the meeting should be sent before the 15th September, at No. 10. Rue de Lancry. M. Boistel has been appointed treasurer of the meeting, and to him the subscriptions, amounting to thirty francs for each member, should be addressed. These subscriptions are intended to defray the cost of publishing the papers that may be read.

Panama Canal.—The engineer in charge of the boring operations being carried out for the Panama Canal reports, according to the *Engineer*, that the borings had proceeded to a depth of about 100 ft. from points, the altitude of which varied from 200 ft. to 260 ft. above the level of the sea, without encountering the rock *in situ*. The material was apparently a more or less dense brecchia or conglomerate of rounded fragments of rock embedded in argillaceous matter. The fragments of rock are in a state of decomposition, and, after exposure to the atmosphere, a slight touch will cause them to separate into concentric layers, leaving a compact central nodule. The existence of these globular blocks on all sides, and distributed over the surface through the defile, leads to the inference that the geological structure of the *col* to be cut through will prove to be similar throughout, more especially as the rocks met with most abundantly on the Isthmus are conglomerates and tufa.

Railways in 1880.—Although the "Railway Returns" for 1880 have not yet been issued by the Board of Trade, some of the main features of the movement, as ascertained from the "Statistical Abstract for the United Kingdom from 1866 to 1880," has been given in the *Builder*. In the following figures the returns for 1879 can be compared with those for 1880:—

Length of railways open in the United Kingdom:—

1879	17,696 miles.
1880	17,945 ,,

Total capital paid up in shares and loans:—

1879	£717,003,469
1880	728,621,657

Number of passengers conveyed (exclusive of season-ticket holders):—

1879	562,732,890
1880	603,884,752

Number of passengers per mile:—

1879	31,800
1880	33,652

Total traffic receipts:—

1879	£59,395,282
1880	61,958,754

Traffic receipts per mile:—

1879	£3,356
1880	3,453

Working expenses:—

1879	£32,045,273
1880	33,502,349

Net traffic receipts:—

1879	£29,731,430
1880	30,985,094

Lead in Germany.—The returns for the lead production in Germany, during 1880, show that 853,050 cwt. were produced, against 825,567 cwt. in 1879, or 27,483 cwt. more than in the former year.

Australian Colonies.—A statistical return of the relative positions and aggregate importance of the Australian Colonies at the close of the year 1879, has been lately published at Sydney, from which it appears that the total area in square miles is 2,580,282½, and the estimated mean population, 2,659,779; the revenue was £15,927,488, made up as follows:—New South Wales, £4,475,059; Victoria, £4,621,520; South Australia, £1,662,498; Queensland, £1,461,824; Tasmania, £375,367; Western Australia, £196,315; New Zealand, £3,134,905; total number of miles of railway open, 4,338½; of telegraph lines, 26,841¾; of telegraph wires, 43,816¾. The number of horses, 1,064,640; of cattle, 7,878,556; of sheep, 65,914,236; of pigs, 822,039. In these four items New South Wales is greatly in excess of the other colonies; thus of sheep the number in New South Wales is 29,043,392, while in the other colonies the numbers stand as follows:—Victoria, 8,651,775; South Australia, 6,140,396; Queensland, 6,065,034; Tasmania, 1,834,441; Western Australia, 1,109,860; New Zealand, 13,069,338. In respect to cattle, Queensland nearly equals New South Wales, the figures being—New South Wales, 2,914,210; Victoria, 1,129,358; South Australia, 266,217; Queensland, 2,800,633; Tasmania, 129,091; Western Australia, 60,617; New Zealand, 578,430.

Gold Production.—It is reported that the total product of gold in the whole world last year was 118,000,000 dols., nearly half of which was mined on the continent of America. The product of silver is said to be 94,000,000 dols., of which 76,000,000 dols. was produced in that country. The grand total of precious metals was, therefore, 212,000,000 dols., an increase, as compared with the three preceding years.

International Exhibitions.—An Industrial Exhibition will be opened at Oglethorpe-park, Atlanta, Georgia, on the 5th October, which will remain open until the 31st December. It was originally named the International Cotton Exposition, but it was subsequently decided to admit other textiles, and now all industries are to be included. The South American and International Exhibition to be held at Buenos Ayres, will be opened on February 15, 1882. Some English merchants, at Shanghai, propose to organise an International Exhibition to be held in that city in 1882.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE ART OF LACE-MAKING.

By Alan S. Cole.*

Lecture II.—Delivered Monday, April 11, 1881.

Needlework upon a material. Needlework upon separate threads. Venetian needle-point lace. Needle-point and tape lace. French needle-point lace-making centres. English and Flemish needle-point lace.

I. In my previous lecture I tried to show when the art of lace-making arose, and by whom it was first practised. This evening I propose to deal with one of the principal methods of lace-making, and the designs worked in this method. Lace, as an ornamental and open arrangement of threads, has been and is still produced in various sorts of threads. We have laces of gold and silver threads, of white, black, and coloured silks, and of white threads, which latter may be of linen or cotton. The white linen thread lace is that in the production of which the most notable artistic designs have been used. Accordingly, with this particular class of lace, I propose mainly to deal. Broadly speaking, hand-made white thread lace is a textile fabric perfectly distinct in character from a woven textile fabric. As a rule, a woven material is close, and patterns are wrought in it by varying the interweavings of the threads, and by using variously-coloured threads.

II. Now, hand-made lace is produced by looping, or plaiting, or twisting threads together. The looping is done with a sewing needle, and the thread, by means of the needle, is constantly at work, being twisted and looped around and between certain fixed threads, which form the backbone of the pattern to be wrought. Plaiting and twisting is done by using several free and loose threads one after another, so that single threads are by turn brought into operation. This latter method comes under the heading pillow and bobbin-made lace, and with this we shall deal in the next lecture. For the present, we are to consider the looped and twisted thread work done with a needle, and hence called needle-point lace. Needle-point and pillow-laces are the two chief divisions of the hand-made laces. Without some acquaintanceship with the methods of their productions, it would be difficult to detect certain of their salient characteristics. To the sight, the difference between these two classes of lace (pillow and needle-point) is often quite marked. For instance, one may compare a piece of Valenciennes pillow-lace with a piece of Venetian needle-point lace. The Valenciennes pillow lace is quite flat and thin in appearance, whilst the Venetian needle-point lace is marked by portions in relief and a sort of modelled appearance. (Figs. 1 and 2.) A similar difference would

Fig. 1.

Valenciennes pillow lace.

not be apparent if we compared the same piece of Valenciennes with a very delicate Venetian needle-point lace, called "point de Venise a réseau."

Fig. 2.

Venetian needle-point lace.

The variety of pattern which we should find in three such specimens could not even be taken as a guide to class of work, as respects needle-point and pillow-lace, since, in the halcyon days of lace-making, the same pattern might be worked by the needle and on the pillow.

III. Attention to the characteristics of workmanship in laces has often been too slightly paid by those who have otherwise shown themselves to be con noisseurs in the matter. The late Mrs. Bury Palliser, whose name is closely associated with

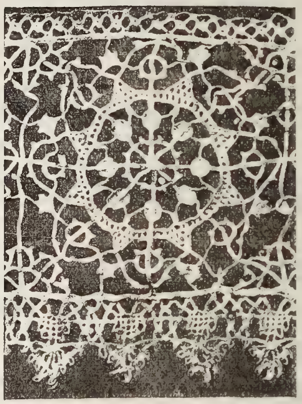
* The right of reproducing the illustrations is reserved.

the history of lace, not unfrequently had failed to acquaint herself with such characteristics. She described some needle-point lace as pillow-made lace and *vice versâ*. It would be ungrateful on my part if I allowed you to infer from these remarks that I was not sensible of my indebtedness to Mrs. Palliser's "History of Lace." Her patient research was almost exclusively devoted to the exhumation and laborious accumulation of records about lace. In this respect chiefly her history of lace is a valuable volume of reference. I must repeat, however, that records and writings hardly seem to be a first source from which materials for forming an acquaintanceship with lace-making are to be drawn. The abundance of existing specimens of all sorts of lace invites our attention, and enables us to trace developments and phases of the art in its productions. When methods of workmanship and styles of design have impressed themselves upon us, then we may have recourse to records and writings, and fit together in as complete a way as we can, the evidences we have thus obtained. I will not say more on this matter, but proceed now to ask you to consider with me features of workmanship in needle-point laces.

IV. Without referring to any particular class of needle-point lace, it will be seen that a beginning must be made somewhere. The pattern governs this beginning. Say then we want to make a little square in lace. We first draw the form on a piece of paper or parchment. Parchment being less destructive is the best. Then lay upon the lines a thread which is fastened here and there to the parchment by stitches. Having completed this thread skeleton pattern, we begin to build a compact covering of white threads upon it, which we do in ordinary button-hole stitch, the result of which is that the skeleton outline becomes a well-marked figure. This is the very simplest form of needle-point lace. If we want to go a little further, and place, say, a pattern in the centre of the square, we should draw one pattern, and then outline it with thread, taking care to attach the lines of this addition to the main lines of the square, and then we proceed with one over-casting of button-hole stitches. There remains now the question how the pattern is to be taken off the parchment. This is easily done, by neatly cutting the stitches at the back of the parchment, which stitches you will remember were those which held the first skeleton outline down. The lace is thus released from the parchment, and the pattern is ready for use for another piece of lace. However, all that we have done is to produce a sort of geometric form of even lines, and this is virtually all that was done at the commencement of needle-point lace-making. Much depends, as you readily perceive, upon nice thread and careful patient working; the least scamping or putting a loop out of its order, takes away from the compactness of the work; and irregularity and loosely made lace condemns itself.

V. Before leaving the early and geometric stage of lace, as we have seen it, which, by the way, was called "punto in aria" (see Fig. 3), a term you will recollect from my first lecture, I think we may find it useful to glance at a few of the classes of white thread embroidery which existed before, and contemporary with "punto in aria.' We have seen that the beginning of lace is separate threads. This is quite reverse of embroidery, which requires a stuff as a foundation.

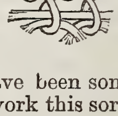
Fig. 3.



"Punto in aria."—Geometric design, with an edging of plaited and twisted threads.

VI. When the fashion of ornamenting white linen garments was getting up to its zenith, people devised methods of decoration other than that of merely loading the surface of a stuff with embroidery. A lightness was obtained by cutting out bits of the stuff, or by punching series of little holes, like the tailor bird. One of the more elaborated forms of this cutting-out work was 16th century Venetian "reticella," which is also called sometimes "tagliato," or cut work. The designs for this sort of work, difficult to distinguish from much "punto in aria" done from similar patterns, are also geometric. The principal lines are rectilineal, and this arises from the fact that the cuttings-out from the stuff generally followed the woof or warp of the linen. These rectilineal lines consist of either very narrow strips of linen, or three or four of the uncut threads, worked over with button-hole stitches, just as our skeleton outline in "punto in aria" was secured. Between these lines may be circular and radiating forms, which were worked like "punto in aria;" and it is curious to notice that, although the embroiderers of linen soon devised methods of inserting into places cut into linen such open ornamented work as done in Fig. 4,

Fig. 4.



yet they seem to have been some little time before they were able to work this sort of ornament, so as to form a band or trimming, independently of linen as a foundation.

VII. Another cut or "tagliato" work done with linen was of a very obviously cut character, as you see from the specimen here shown. This vandyked scroll is cut out of a strip of linen, and is picked out with fine gold wire, fastened along its edges. (Fig. 5.) The name "tagliato a

foliami," or cut work with leaves, was given to a very rich kind of lace, and this has led to some confusion; as the term "cut" indicates a process

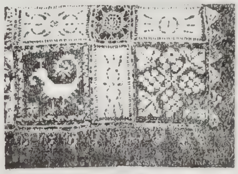
FIG. 5.

Vandyke of cut linen work.

having nothing to do with the making of lace like that of Fig. 2, which was, nevertheless, called "tagliato a foliami." Much as it may look like cut linen, with little reliefs and ornaments embroidered upon it, it is a fine specimen of very elaborate lace-work, produced entirely by needle and thread upon a parchment pattern, so that cutting has nothing to do with the shaping or ornamentation of the pattern.

VIII. Continuing with the white embroideries upon stuff, we may look at a specimen of drawn thread-work. Here we have another sort of work, differing from either of the cut works. The withdrawal of the threads regulated the pattern to be produced. A well-curved scroll had to be content with being approximately rendered in small squares. The back ground to such work appeared to consist of a net of square meshes. This effect was obtained by whipping fine thread around the undrawn threads of the stuff. Just the reverse of this work is the very well-known darning upon net, of which there are many made machine imitations now. For this sort of work, Frederic Vinciolo made many patterns, some of the earliest of which date from about 1570. The Italian name for the work was "punto a maglia," and the French "lassis" or "lacis." The Italians, or rather Venetians, preceded the French in this sort of work, though the French carried it to a degree of admirable perfection. I remember that in the South Kensington Exhibition of 1874, there was a most complete specimen of this darned work, a large linen curtain, or altar cloth, set with squares of darning upon a net ground, in which were represented figures of the zodiac and of the seasons. All of them were after designs by Vinciolo, as may be seen in such well preserved copies of his works as those belonging to Mr. Alfred Huth, who kindly allowed me to consult his copies of them. It was particularly interesting in this church hanging to notice the final squares, in one of which were the words, most carefully darned, *Louant Dieu j'ai fini mon ouvrage*, "praising God I have finished my work," and in the other the name of the worker, "Suzanne Lescallez, 1595." The cloth, after the Exhibition, went back to France, and I don't know where it is, but it is so complete a specimen, that if by chance any one happens to meet with it, I hope they will make a careful note of its whereabouts. On a far smaller scale, and of altogether less artistic importance, are the few squares of "lacis" or darning, introduced into this cloth. (See Fig. 6.) Those appear to be reproductions of some

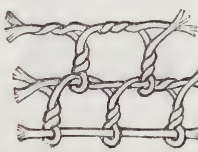
FIG. 6.



Corner of an embroidered linen with squares of "lacis" and "Reticella" inserted, and edged with twisted and plaited threads.

of the smaller designs by Vinciolo. This Vinciolo is an important personage in the history of lace. Besides the darning work, or "lacis," which is not lace, he popularised the taste in France for "points coupés," the French name for "reticella" and cut-work, and also for "punto in aria." He seems to have borrowed much from different sources, and it is interesting to compare his patterns with those done by C. Vecellio, a notable and rather later designer and writer about costume towards the end of the 16th century, and some relation to the great Titian, and with those done by a much-esteemed woman, named Isabetta Catanea Parasole, whose patterns were published in Rome about 1590 and early in the 17th century. No doubt Vinciolo owed much of his success to the patronage which Henry III. and Henry IV. of France and the ladies of the French Court accorded him, though, at the same time, we must not forget that he was a man of energy and refinement, as his books show. He is almost the only early pattern maker who attempts a description of how the patterns are to be worked. His descriptions, however, are more enthusiastic than instructive. They are given by him in verse, in what he calls a discourse upon "Lacis." His divine *chef d'œuvre* is not a matter of chance; it has been well considered and planned by number and measure. Before leaving the "lacis" or darning on net, I would observe that the name given to the net was "résuil," and this name must be noted, since we find it, later on, applied to ground-works of meshes used in laces. You, all of you, know what netting is, and how simple an operation it is to

FIG. 7.

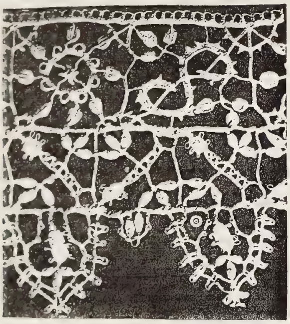


make one mesh. I will show you a few meshes done with the needle (see Fig. 7), and you wil

then see the far greater complication of this work, as compared with netting, and yet the name "réseau" in France applies to both.

IX. We have now examined different sorts of embroidery on linen. (1) Work done by cutting holes into a linen foundation; (2) work done by cutting linen into shapes; (3) work done by drawing out threads, and so leaving a linen pattern; and (4) work done by darning a pattern into network. We have also seen specimens of the early geometric laces—the "punto in aria," or button-hole stitch work done upon a thread skeleton; and now I should like to show you a piece of mixed work, in which a little more than mere geometric form is displayed. (See Fig. 8.) The

Fig. 8.



Vandyked border of mixed work, the upper part of needle-point, the lower and dentated part of plaited and twisted threads.

upper part is all of needle-point work, whilst the lower is of plaited work. Some of this plaiting may, no doubt, have been done with a hooked needle. However this may be, I thought is useful to show this specimen, in order that you might not fancy that the whole of a single piece of early work was done in one method only. Patterns for lace like this are to be found, especially in Vecellio's books, about 1590 or 1600.

X. We will now look at a few specimens, from which I think we shall trace a freer sort of design, and, consequently, an increased display of ingenuity in workmanship. We have hitherto seen ornaments, more or less dependent in their construction upon squares and their diagonals. But the pattern-

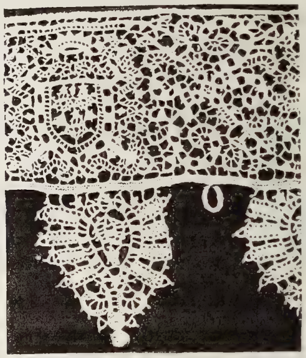
Fig. 9.

Italian needle-point vandyke.

books of the end of the 16th century give us designs for scrolls, with the introduction of all kinds of odd figures to be worked in lace. The specimen of this class (see Fig. 9.) dates, probably, from about 1580. I want you to notice how the different details in the design touch one another at different points of contact. There are very few little tyes. Considerable parts are of flat-looking work, work which in this photograph looks like linen. It is composed of a series of closely-drawn loops worked very much as shown in Fig. 4.

XI. In the specimen in Fig. 10, I want

Fig. 10.



Needle-point lace, showing use of tyes or "brides."

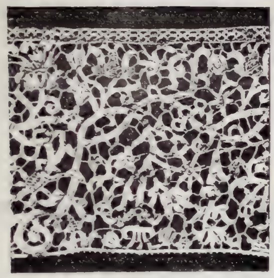
you to notice the numerous little tyes which are used to hold the pattern together. These tyes are called "brides." The design too of this piece is more vivacious than the simple rosettes and radiations. In the centre we have a shield surmounted by a crown. Curves slope from each side of it, to meet beneath a sort of fan pattern, from the top of which grow a little *fleur de lys*. The vandykes which hang beneath, are repetitions of this fan device, and are terminated with little balls. Between the vandykes are small loops, which suggest loops for buttons, but I cannot say for what particular use this specimen was intended. From the character of the design I think the specimen dates from about 1580 to 1590, and is Italian. It might, of course, be a French or other imitation of Italian work.

XII. Very important work of this flat character was made, and amongst the white threads gold threads were introduced. I believe that Sir William Drake possesses as fine specimens as ever were wrought of this white and gold thread needle-point lace. They are, I think, of early 17th century design and workmanship. Originally they came from Messina, to which place they may have been taken by some wealthy person at the time when that city was a centre of considerable importance, notable for its independent and aristocratic prosperity.

XIII. In the succeeding examples, you will notice a development of flowering stems and scrolls. A change of design had thus begun to take place at the end of the 16th and beginning of the 17th centuries. Here (in Fig. 11) you will see too a greater use of the "brides" than any we have previously noticed. Along the borders of the stems or scrolls is a little raised line. This is called the "cordonnet," a feature not observable in the fine gold and white flounce of Sir William Drake's. Parts of the pattern are diversified by

changes of stitch. Instead of compact work everywhere we should see little open works. In the centre of some of the little blossoms there are wheels and

FIG. 11.

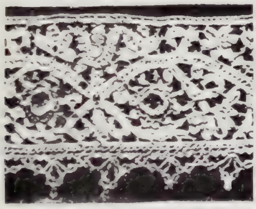


Venetian needle-point lace.

radiating lines. These details are worthy of our attention, and are called fillings-in, or "modes." They are specimens of the first forms of elaboration in lace, which in their further matured state became important features, giving delicate grace in appearance to laces of the best period.

XIV. It may have been about this time, namely, the commencement of the 17th century, that lace workers pressed tape into their service. Instead of patiently composing their scrolls and flowers in button-holed stitched fabrics, they found tape could, for comparatively rough and ready general effect, answer their purpose. Here we have two

FIG. 12.



Tape lace, with needle-point work and an edging of plaited and twisted threads.

examples of tape lace combined with needlework. Workers in pillow lace also used tape in a similar way. This little strip (see Fig. 12) may be Italian,

FIG. 13.

Tape lace worked with the needle.

but tape lace was not only produced in Italy. This specimen (see Fig. 13) may not unlikely be of Flemish workmanship. My reason for thinking it Flemish is the style of the flowers along the borders, which appears in a lace (see Fig. 14) much liked by the Flemish in the first half of the 17th century. The points of resemblance lie in the

FIG. 14.

Flemish lace of the 17th century.

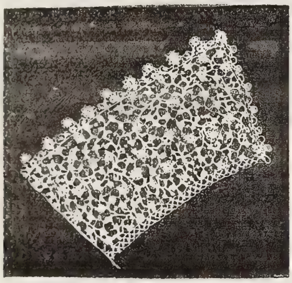
arrangement of the petals of the blossoms, which takes a fan shape.

XV. Before leaving the question of tape laces, it may be well to state that the weaving of tape seems to have been begun in Flanders, about the end of the 16th century, or the beginning of the 17th. Tape, so far as I have been able to ascertain, did not come to be made in England until the 18th century, when, according to a note I have had from Messrs. Phillips, the well-known tape manufacturers at Manchester, their predecessors brought over, in the year 1747, two Dutchmen, of the name of Lanfort. Under the tuition of these Dutchmen, the people in the village where Messrs. Phillips have mills at the present time, learned how to weave tape in the loom. The start in England was up-hill work, because of Dutch competition. There were at least 1,000 looms at work in Holland before there was one in England. However, in about thirty years, the trade greatly developed, and, in the course of a half century later, several other tape looms were started. This was about 1820. Since then the manufacture has increased. Before 1822, tape was made in cottages; but, in or about 1822, the idea of getting the workers and their looms under one roof had taken root, and mills were built. Then came steam power and water power for driving the looms, instead of human power. Effective work has been done with tape, in connection with the method of pillow-lace making. Work of this sort is sometimes called guipure. But guipure is a class of work totally distinct from this, and about guipure we shall hear something in the next lecture.

XVI. However, we must now return to needle-point laces. Up to the present we have arrived at scroll designs more or less flatly worked, held together by tyes or "brides," enriched with little varieties of "fillings in" or "modes," and emphasised with small raised lines or "cordonnets." All this sort of work was done upon a thread skeleton pattern just as the first needle-point laces were made. Fancy in design and workmanship, however, was now becoming quite vigorous. We enter a period, soon after the commencement of the 17th century, when lace workers produced beautiful solid looking work,

which is almost like fine 14th century Gothic tracery, carved in ivory. Its exquisitely worked relief carried recent admirers of it far away from the time when it was first produced. They tried to identify it with a needlework which an Italian poet, Firenzuola, a hundred of years before the existence of this relief-lace, described as "sculptured in relief." As the size of the altar-cloth, flounce, border, or collar seemed to demand, so did the lace-workers vary the size of their designs and work. For instance, a collar would be designed and worked as this one. (See Fig. 15.) The

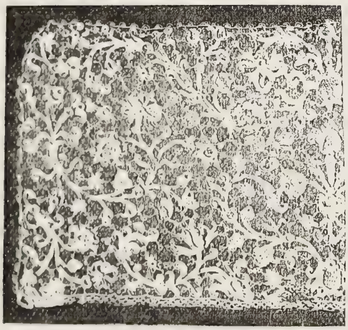
Fig. 15.



Part of a collar of minute Venetian needle-point lace.

figure is not quite distinct, in showing the amazing delicacy of the relief work and its enrichment. Each of these little blossoms, actually about the size of sixpence or threepence, is a bouquet in itself of hundreds of the most finished lilliputian loops, finely worked in button-hole stitches. Again, for a border or an ornament to hang beneath the chin, we have specimens such as this (see Fig. 16),

Fig. 16.

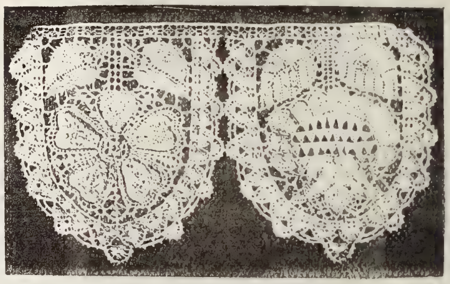


Venetian needle-point lace.

and in this specimen the decorations worked upon the little tyes should be noted; while, for a sort of collar, the ends of which spread flatly over the breast of some courtier or minister, say like Colbert, we have samples as shown in Fig. 2. In all these specimens is a rich expression of stately scroll design—varied fillings - in or "modes," "galleries," or successions of minute loops "picots" placed one above the other. This was the kind of splendid needle-point lace, exclusively originating, I think, from Venice in the 17th century, which the nobility and wealthy personages of the time wore, and of which vestments and altar-cloths were made for churches.

XVII. A contrast to this galaxy of wonderful lace is to be found in the needle-point lace of England during the 17th century. A photograph lies on the table, in which is shown various scallops on vandykes of English needle-point lace of the 17th century. Remarkable amongst them are the two larger vandykes, which you will see contain—the one, a figure of a man—the other, a figure of a woman, depicted in the costume of the period. The way in which this work was done is precisely similar to 17th century flat Venetian needle-point lace. Here is a specimen of the English work. (See Fig. 17.)

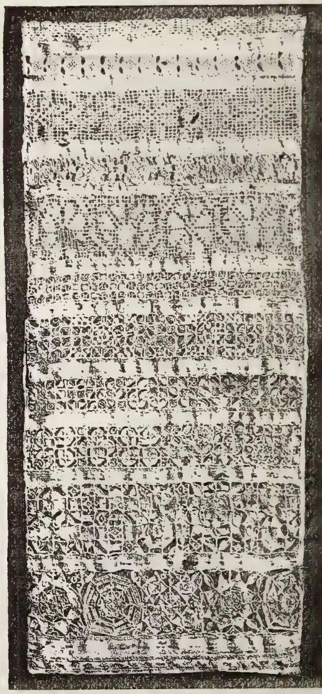
Fig. 17.



English needle-point lace.

XVIII. Scallops of "punto in aria," insertions of "reticella," and of similar design, may also be seen in Westminster Abbey carved upon the tombs of the

Fig. 18.



English sampler with needle-point stitches.

infant daughters of James I., which are dated 1606 and 1607. Who may have made these, who can say? In the English sampler of lace stitches (see Fig. 18), we have, luckily, the maker's name

and date. "Margreet May, 1654" wrought this sampler, and in it you will see cut-work, drawn linen work, "reticella" work, and "punt in aria," or true needle-point stitches. It is a most valuable little epitome of English lace work in the Puritanical times, when school children like "Margreet May" were trained to have an interest and to take a pride in their own labour. Such as she were, evidently, not to be extinguished by a mere registration number, or lost in the midst of numerical grades in a standard.

XIX. I must now ask you to put yourselves twenty years or so back before this 1654, and to consider the position up to which we seem to have traced needle-point lace making and design.

XX. The little tyes holding the patterns together have hitherto been but arbitrarily arranged. We have seen that at first they were plain little lines, as in Figs. 10 and 11; we have noted the decoration of them by means of the addition to them of little loops or "picots," as in Fig. 16. We now come to a period when the designers arranged them into an orderly pattern, similar to the honeycomb of the bee. Messrs. Hayward have kindly lent a very remarkable flounce, in which this character of honeycomb ground is seen, and Fig. 19, is taken from smaller specimen, which was

FIG. 19.

Venetian needle-point lace.

used as the veil to a chalice. The little tyes ornamented with small loops form a background of hexagons. The style of design is no longer the flowing and dignified scroll, but consist of a balanced arrangement of fragmentary details, in the ornamentation of which clusters of picots is noticeable. A similar style in using disconnected ornaments is observable in Messrs. Hayward's flounce.

XXI. But before quitting the long flowery scrolls, I want you to observe the varieties of fillings-in, the growth of which we had begun to notice in Fig. 11, and I again refer you to the collar of raised scroll work. (See Fig. 2.) At the same time that new effects were being tried by designers and workers, the best forms which had preceded these attempts were also preserved in use. Hence you will see that, although in time styles of design supplanted one another, there were lingerings of old styles contemporaneously worked with new styles. And it is the consideration of incidents like this which I think must always puzzle connoisseurs of styles of ornaments in their attempt to fix a very precise date to a certain pattern. We may know that such and such a pattern may have been worked at a certain date, but we cannot fix with precision its first introduction, or its final appearance, neither can we be confident that a repetition of it may not be of very later date.

XXII. With the style of balanced arrangements of detached ornaments which is closely connected with the style known as Louis XIV., we find the first indications in lace of a groundwork of meshes made with a needle. (See Fig. 20). This

FIG. 20.

Needle-point lace with ground of fine meshes.

figure is rather indistinct, and does not show the ground of meshes clearly. Perhaps, however, the indications of it are sufficient to let me ask you to take my word for it that the ground is composed of meshes, which are in the main similar to those of Fig. 7.

XXIII. You will hence note how that we are getting into a period when grounds of meshes were being used. The daintiest of all Venetian needle-point laces, with fine grounds, is the "Point de Venise a réseau." This most delicate work was contemporary with soft pillow-made laces, which no doubt were intended to be its rival. In its production were combined the highest elaboration of design and workmanship, together with a thinness and beautiful softness of texture. It is one of the rarest of all laces. It marks a transition from preceding heavy to succeeding light laces. It followed the change which articles of costume, like collars and cuffs and trimmings, underwent from the 16th to 17th centuries.

XXIV. High-standing ruffs, like those worn by Queen Elizabeth, had been trimmed with "reticella" and geometric "punto in aria." But the vandykes expanded in size, and instead of shooting off from borders of the ruffs, became unmanageable for such

use, and so began to lay down, falling over the shoulders, instead of starting from them. The size of lace-trimmings grew too. Instead of vandykes or "dentelles" pendent from the knee or along the edge of a skirt, whole flounces offering greater field for display of more ambitious designs were produced. The Dauphin of Louis XIV., when christened, is pourtrayed as having worn a mantle with a deep bordering of handsome scrolls of raised Venetian point similar to that in Figs. 2 and 16. Tabliers and aprons of ladies' dresses were similarly composed of such lace. As patterns and work became less cumbersome, ladies adopted expansive sleeves of delicate lace, which well became their soft arms. A degree of softness thus asserted itself, and a climax of this softness is to be found in the remarkable "Point de Venice a réseau." The old vandykes had, in fact, disappeared, though their name, "dentelles," was retained for their successors, from which the dentated character was almost entirely extinguished.

XXV. We have now arrived at about 1660 to 1680, and this is an important date to remember in connection with the history of lace.

XXVI. A view of the situation might be stated to be, Venetians, at the end of their famous hundred and twenty years of work, to bring lace to a perfection, and other countries doing their utmost to acquire the art from them; some, like the Flemish, progressing slowly and naturally, following Venetian patterns upon the pillow; others, like the French, bent upon stepping by any means to a front rank.

XXVII. The desire of the French to be able to make fine lace was undoubtedly most strongly expressed in an edict dated 1660. Louis XIV.'s minister —Colbert—was the prime mover. He had taken stock of the increasing love of the French people for Venetian and Flemish laces. His love for the fine arts in all their branches, and his great energy, were principal elements in the framing and issue of this celebrated edict. Through it lace-making establishments were founded at Alençon, Quesnoy, Arras, Remis, Sedan, Chateau Micrry, Loudun, and elsewhere. The State made a contribution of 36,000 francs in aid of the formation of a company to carry out the work. Instructions were included in the edict that the lacemakers should produce all sorts of thread-work—as much those done with the needle as those worked on a pillow or cushion, in the style of the points which were made at Venice, Genoa, and Ragusa, and other foreign countries. These French imitations were to be called "Points de France;" and although attempts have been made to identify certain laces as "points de France," I think, considering the variety of laces which were to be imitated, and the classification of them under the one name, that such attempts at identification of "points de France" cannot be very successful. As we know well, clever handicraftsmen can succeed in producing counterfeits which defy detection from originals. The local origin of a good deal of lace, made, perhaps, in France, in the middle of the 17th century, cannot, therefore, be determined. I mention this, since Monsieur Seguin has made up his mind that certain Venetian "rose point" laces are French. They are essentially Italian in style of pattern and work, though being possibly worked by French hand, they may be French. A French work, re-printed in England, might analogously be called an English book.

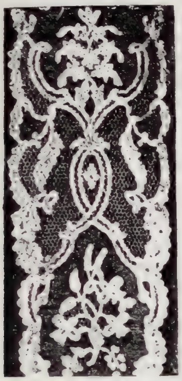
XXVIII. An excellent article in the *Edinburgh Review* of January, 1872, contains some interesting particulars about the establishment of the lace factories in France. The writer was furnished by the well-known antiquary, Mr. Rawdon Brown, of Venice, with extracts from Venetian State papers. A most important incident connected with the starting of these French lace-centres, was the employment in them of Venetian lace-workers. Intrigue and diplomacy were put into action to secure the services of Venetian workers. The Italian Ambassador at Paris in 1671 writes:—"Gallantly is the Minister Colbert on his way to bring the 'lavori d'aria' to perfection;" and six years later, Domenigo Contarini, jealous of the ill-effects which were evidently ensuing, to the prejudice of lace-making in Venice, alludes to the "punto in aria," "which the French can now do to admiration." Thus, from 1660 to 1677, we have a period when French labour, under State protection, was being systematically trained, by imported Venetian instructors, in the art of lace-making.

XXIX. The style of design adopted by the French was certainly much more floral than the Venetian. It was lighter, and more in accord with that lightness of texture which lace was developing for itself. Great attention was paid by the French to ground-works, which, in respect of the honey-comb "brides" (see Fig. 19), and meshed grounds (see Fig. 20), they distinctly copied from their Venetian masters. Mrs. Bury Palliser considered that French lace-makers could not be taught to imitate the true Venetian stitches, and that designs for points d'Alençon were planned accordingly to meet this deficiency, but I think the study of a few specimens here before us will be sufficient to show us that, however fresh a departure may have been taken by the French in the matter of design, their cunning in doing delicate needle-point stitches became as great as that of their instructors, the Venetians. It is surprising, I think, how confused people become if they have not fixed in their minds the difference between design and workmanship. The best ability in representing the worst design generally runs a risk of being condemned. It is the pattern, and not the workmanship, that should be condemned; and very often precisely the reverse of such cases occurs, when a well-drawn pattern, in spite of bad or inferior workmanship, asserts itself, and is then held up as a good piece of work.

XXX. To return, however, to French ground-works, and their particular connection with early distinctive French needle-point laces, you will remember the regular hexagonal grounds of Venetian laces (see Fig. 19). This feature, done generally on a smaller scale, is the distinguishing mark of what was called Point d'Argentan. I am afraid I shall make too great a demand upon your patience if I go into the question why Point d'Argentan and Point d'Alençon are virtually one and the same class of lace; frequently in style of design, and always in character of work. If you want to see my views upon this question, I must ask you to let me refer to my book on ancient lace, which the Arundel Society published for me in 1875. I will now show you a piece of lace in which the special groundwork of Point

d'Argentan and that of Point d'Alençon appears. (Fig. 21.) The clearly defined honeycomb ground in the centre of the figure is Argentan (so called), and the cloudy ground, composed of fine meshes, is the Alençon ground. Judging from the pattern of this lappet, I think it is likely to be of the latter end of the 17th century.

FIG. 21.



French needle-point lace.

XXXI. The variety of groundworks and fillings-in in the Alençon laces is very remarkable. Large flounces, like one which belongs to Mrs. Alfred Morrison, are rich in all sorts of fantastic devices, of design, and of work. The underlying principle of the stitchery is the button-hole stitch, worked upon skeleton patterns of fine thread, and sometimes of horsehair. Here is another specimen of Alençon lace. The groundwork is composed of what is termed "réseau rosacé." This "réseau rosacé" consists of little solid flat hexagons of button-hole stitched work set in frames of hexagons. A special characteristic of the Point d' Alençon laces is the button-hole stitched "cordonnet." In the Venetian "Point à réseau" the outlines are of a thread. You will notice this if you examine the actual specimens here shown. To thoroughly enter into minutiæ like these of fine lacework would, I am afraid, take us into considerations almost never-ending. I hope I have been able to present to you this evening a sort of connected chain of phases of needle-point lace-making. I might extend it further, and speak of the Brussels needle-point laces. It is, however, more or less evident that the Flemish or Belgian, in the matter of needle-point lace, imitated their neighbours the French, though no doubt they had imbibed a large amount of knowledge in the course of their far earlier relations with the Venetians.

XXXII. I would conclude my remarks this evening by saying that the basis of all needle-point lace is the button-hole stitch, and that the features of work which you have to detect in judging a needle-point lace from a pillow-made lace are those of this button-hole stitch.

MISCELLANEOUS.

ORANGE CULTURE IN SYRIA.

Some notes on orange culture in a recent consular report from Beyrout, are quoted in the *Times*, from which we learn that the two districts in which oranges are the most plentiful are those of Jaffa and Sidon. The orange trade began to assume considerable proportions some 40 years ago, when the new government of Egypt took shape, and it is now one of the most profitable in the two towns above mentioned. Unfortunately the inhabitants, allured by first gains, commenced planting gardens, and expending money beyond their resources, the result of which has been that, in spite of all remunerations for small outlays, their improvidence has placed most of them in the power of money-lenders, who continue to advance at interest of 15 to 20 per cent. However, a company has lately been formed in Jaffa to negociate loans with orange cultivators, and if its operations be carried on fairly, we may expect an extension of horticulture, with benefit alike to the company and the borrowers. At the present moment Jaffa possesses some 340 gardens, averaging from 2,000 to 2,500 trees in each. The crop of fruit from these may be put down at about 36,000,000. A garden costs from 40,000f. to 50,000f., and brings in 4,000f. to 5,000f. per annum. For several miles round Jaffa extends a fertile plain, on which water is always to be found at a depth of 40 ft. or 50 ft. With capital and enterprise much of this might be planted, and the orange trade doubled in a short time. The present system of irrigation is that of small wells, from which the water is drawn by mules; but experiments have proved that very little engineering skill would be required in order to turn the streams of the River Andjah, some four miles from the town, over the plain. The land near Jaffa would then be cheapened in proportion as the value of that freshly-watered rose. At present, unplanted land close to Jaffa, able to support 2,000 trees, is worth 2,000f. to 3,000f.; but at two or three hours' distance it will fetch only 5f. to 6f. a deunum. The export is carried on chiefly by sailing boats for Egypt and Constantinople, and by steamers for Russia, Trieste, and Marseilles. Exportation in cases is a comparatively recent introduction, which has given considerable impulse to business with Europe. The orange gardens of Sidon are cultivated on the same principle as those of Jaffa. An acre of land at Sidon is generally valued at from 6,000f. to 7,000f., and is capable of bringing in an income of about 600f. The exportation begins in September, and is at first almost exclusively directed to Russia, till the winter closes the Black Sea ports, when it is continued to Trieste and Egypt. European cargoes are packed in paper and close cases, the rest are sent in open crates. Each case contains some 300 oranges or lemons, and last year's export is reckoned at 20,000 cases, all of which fetched very high prices, especially lemons in Russia. The average prices are for 1,000 lemons 150 to 170 piastres; while for 1,250 oranges, reckoned as a trade 1,000, the cultivator receives 70 to 80 piastres.

ESPARTO OR ALFA.

By C. G. Warnford Lock.

The celebrated German traveller, Dr. Gerhard Rohlfs, devotes a whole chapter of his new book, "Neue Beiträge zur Entdeckung und Erforschung Africa's," to the subject of "Esparto, and its Increasing Importance in European Commerce," from which the following notes are condensed:—

A portion of the Sahara, known to the French as *le petit désert*, comes within the influence of moisture-laden winds, and is clothed with vegetation. One of the most useful plants, covering almost the whole district, is esparto or alfa (*Macrochloa* or *Stipa tenacissima*). Long known and locally utilised for mat-making, it is only within recent years that the true value of this plant, which needs neither care nor culture, and thrives with a minimum of moisture, has been recognised. It grows in thick bunches close together, presenting a subulate appearance, and reaching a height of six to ten feet. The tenacity of its fibre constitutes its industrial value, for

it is scarcely fitted for consumption as fodder. Indeed, Duveyrier states that it has such a powerful constipative effect, that the shepherds of the desert edge drive their camels and sheep every third or fourth day to drink at mineral springs, in order to counteract the binding action of the esparto diet. Rohlfs himself noticed how soon the camels and sheep grew tired of grazing upon it.

The one word PAPER explains the whole importance of esparto. The day has long since passed when rags and similar stuff sufficed to supply the world's needs of paper. The moment has arrived when new sources of paper material must constantly be sought. This is easily explained when we reflect that the yearly consumption of paper by the four great cultured nations of the world stands thus:—England, 13¼ lb. *per capitem* of the population; America, 12 lb.; Germany, 10 lb.; France, 8¾ lb. These figures are always on the increase. And though Russia takes only about 1 lb., and Austria 4½ lb., the amounts in both these countries double themselves with every generation.

No plant seems better adapted for paper-making than esparto. It may be regarded as an inexhaustible source of wealth, not only in Algeria, but for all northern Africa. Algeria already owes a portion of her railways to this plant. The section from Arzew to Saida is approaching completion, and others are in progress. Some seven or eight million acres of esparto ground exist in Algeria alone.

Hitherto, the greater part of the esparto grown both in Spain and North Africa has gone to England, though the Americans are beginning to import direct from Africa. Up to the present, German paper-makers have not availed themselves of the use of this plant. England, in 1868, imported 95,828 tons—92,927 being from Spain, and the rest from Algeria. But Algeria rapidly attained greater importance, while Spain fell off. In 1874, England's imports were 119,188 tons—54,942 from Spain, and 37,516 from Algeria. Since 1870 other countries have contributed to the total. Tunis and Tripoli figure in 1871 with 11,579 tons, increased to 18,670 in 1874. Malta provided 3,261 tons in 1871, and 7,185 in 1874, not of its own production, but derived from Cyrenaica, and the so-called Libyan coast plateau.

The influence of other lands, Tunis, Tripoli, Cyrenaica, and perhaps the Libyan coast plateau, upon the Algerian and Spanish trade, has, especially of late years, caused a reduction in price. As, however, in most of these lands, robbery is still rife, Spain and Algeria will long continue to enjoy a practical monopoly. How strongly the rational conservation of this valuable plant is urged in France may be gathered from the following words of the journal, *L'Exploration* (1878, p. 156) :—"As in France laws have been made against the felling and destruction of forests, so must the Colonial Government busy itself with the protection of this great staple of the high plateau, and not only severely punish the before-mentioned crimes (burning by the Arabs, and killing of the plants by careless gathering), but also fortify the esparto region against the constant encroachments of the sand of the Sahara. [Rohlfs characterises the latter as a groundless fear, the sand-dunes being, on the whole, stationary.] It must not be lost sight of that all Europe and America are dependent upon Algeria, and that, should the whole esparto district be carelessly left to greedy robbers, who care little for the public property, finally nothing will remain but a neglected waste, an unfruitful steppe." It is as well to observe that, firstly, Algeria possesses, at the utmost, not more than one-sixth of the esparto region, and, secondly, the same land will, when desired, grow excellent wine.

On the subject of adulteration and faulty packing, Dr. Rohlfs quotes at length from Noble's circular of 14th January, 1875.

The preceding remarks indicate what stress is laid upon the export of this plant to France, Great Britain, and the United States, while Germany remains outside. Yet none will suppose that Germany is blessed with a superabundance of paper material. The Leipzig paper trade alone has of recent years a value of about ten million marks (£500,000). It is therefore a reproach to German merchants that they should have paid so little attention to this material. With this object, it is not at all advisable to go to Algeria, nor to Spain, where German merchants would find it difficult to gain a footing in competition with the old English houses. But is not the whole remainder of North Africa open? Not to speak of Morocco, where, especially south from Cape Ger, a wide stretch of country still remains unoccupied, on which esparto forms the chief vegetation—the esparto-grown portions of Tunis, Tripoli, Barca, and the eastward-lying Libyan coast plateau, stretching to Alexandria, are absolutely without any rational commerce; as the natives tear up the esparto, root and branch, so is it carried to the shipping ports, sorted, and sent into the market. Here is a field for German enterprise. Dr. Rohlfs suggests the possibility of establishing esparto paper factories in convenient localities, and supposes that about half of each plant would be available as fuel.

The remainder of the chapter deals with African trade generally, but the whole tenour of it is to urge the Germans to no longer remain passive and unmindful of the resources of North Africa: and Dr. Rohlfs is not likely to preach in vain to his countrymen. Now, if these waving acres of esparto offer such great inducements to the astute and cautious German, do they not merit even greater attention from ourselves? Already our paper-makers have cause to tremble for the future, since France has made such strides on Tunis, and if our merchants allow themselves to be outstripped by German rivals on neutral territory, we shall soon have to import all our paper from the Continent, in spite of all that Mr. Routledge is doing for us.

CORRESPONDENCE.

AUSTRALIAN FRUIT FOR ENGLAND.

I note with interest the information in the *Journal* of 9th inst., page 778, that we may expect fruits of various kinds from Australia. No doubt apples, pears, and oranges can and will be shipped to advantage thence to this country, because all these fruits ripen after being plucked; but I think the writer in the *Colonies and India* is over sanguine as to first-class grapes being able to stand the voyage, and to arrive in such good condition as to compete with home-grown hot-house productions. Be that as it may, my experience of thirty years as a grape grower teaches me that grapes never ripen in the slightest degree after being gathered, but merely wither and shrivel, &c. I think all grape growers are agreed on this point. If I am wrong, I shall be glad to be corrected. James Fildes.

44, Spring-gardens, Manchester, 10th September, 1881.

GENERAL NOTES.

Agriculture in Victoria.—From the lately published agricultural statistics of the Colony of Victoria for the years 1880-81, it appears that while in 1872 the area under wheat was 334,609 acres, under oats 175,944 acres, under potatoes 39,064 acres, and under hay 103,206 acres, the amounts, in 1881, have increased under wheat to 976,416 acres, have decreased under oats to 133,910 acres, and increased under potatoes to 44,773 acres, and under hay to 249,424 acres. The average produce per acre is considerably less in 1881 than it was in 1872. In the latter year, the produce was 13·45 bushels of wheat, 18·76 bushels of oats, 3·22 tons of potatoes, and 1·40 tons of hay. In 1881, the yield has been 9·95 bushels of wheat, 17·61 bushels of oats, 2·79 tons of potatoes, and 1·20 tons of hay.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE ART OF LACE-MAKING.

By Alan S. Cole.*

LECTURE III.—DELIVERED MAY 2ND, 1881.

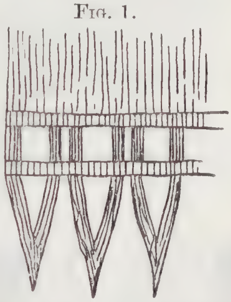
Pillow-made lace. Fibres and threads twisted and plaited to make rope, cord, twine, and braids. Fringes. Grecian fillets. Twisted thread-work in England in the 15th century. Plaited and twisted thread-work. Purls. Merletti a Piombini. Simple work done on a pillow. Manufacture of pins, guipure, tape lace. Pillow laces of scroll design. Grounds of meshes and other characteristics of pillow laces. Italian, Flemish, German, French, and English pillow lace.

I. This evening we are to consider the second division of hand-made lace, namely, pillow-made lace. The outgrowth of needle-point lace from embroidery done upon a foundation of stuff, then upon a web or net of some sort, and at length upon a skeleton pattern of threads, was, I hope, established when we last met. The workmanship of our present subject is quite different. Pillow-made lace is built upon no substructure. It is a representation of a pattern obtained by twisting and plaiting threads. In the midst of the endless combinations of forms inspired by the sight of objects of all sorts, men, animals, flowers, leaves, fruits, as well as historic treatments in depicting such forms, that which in primeval times claimed respect as being a pattern, now seems to relegate itself to a position, which, if not considered to be contemptible, is at least so humble as to pass into insignificance. Nevertheless, students of the history of ornament find much that is admirable and instructive in the simplest juxta-posings of lines and curves. And in glancing at the use of patterns wrought in twisted and plaited threads we must not, of course, omit to note patterns of primitive character.

II. The ancestry of laces made on the pillow may be found in examples of primitive twistings and plaitings of fibres and threads. In my first lecture I alluded to a few such examples, and I hope you will excuse me if I again briefly remind you of them. They must be dissociated from works of the loom. They come into the class of rope, cord, and twine making. They are also nearly related to smaller cords, such as corset laces, sleeve laces, boot laces, and to another branch of the same family, namely, narrow braids and tapes. Rope making was known by the Egyptians in early times, and it appears probable, if not certain, that this manufacture was at a similar early date practised by Oriental people living much further west, as in the Hindoo Peninsula, and the immense Mongolian Continent. Amongst the peoples living there, the use of ropes and cords for purely utilitarian purposes was apparently followed by the manufacture of finer plaited and twisted cords and threads made of finer materials than rough fibres, such as coloured silks and metallic threads, wires, or delicate metal strips for decorative purposes. These came "in response to the first spiritual want of barbarous man," which, as Carlyle says, is decoration. At what date fringes were used it is perhaps impossible to say. Besides fringes, there seem to be coeval fine twisted threads upon which to string pearls, precious stones, and beads for personal adornment. As well as these we should not forget girdles or cinctures, which come to us from impenetrable epochs of religious myths. Nets of plaited, golden, and silken threads were worn by Grecian women. Fillets for binding their hair and foreheads were often narrow braids made with silken and metallic threads. Müller specifies the *diadema*, or fillet, which was placed among the hair, and was of equal breadth all round the head. The *tœnia* was usually a broader fillet with two narrower ones at each end. Hercules and athletes are represented as wearing fillets composed of several *tœniæ* twisted together.

III. We saw an example of the art of plaiting and twisting cords together for borders, 800 years before Christ in Assyria. But the design of this was quite primitive. This primitiveness of design in twisting and plaiting threads appears to have continued for a long time. A different treatment of borders occurs upon the costume of certain Dacians who are depicted in the famous column, coming before the Emperor Trajan. (Fig. 1.) This is some 900 years later than the Assyrians.

FIG. 1.



Border from Dacian costumes, sculptures on Trajan's column (2nd century).

IV. Evidences of similar minor details of costume from the 2nd to the 12th century are scattered, and rather difficult to obtain. Something, however, can be gleaned from early Christian sculptures, frescos, and Mosaics, and from Byzantine works of art.

V. As I mentioned above, the term lace has long been applied to braids and such like. Gold braid especially, or as it is called, gold lace, is of ancient origin. Scandinavians and Danes apparently made such gold lace, remnants of which have been discovered buried in England.

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VI. Before stockings came to be knitted, Romans and Barbarians used to encase their legs in strips of coarse, plaited, and woven material. These braids, as they might be called, were neatly plaited round the leg, from the knee to the ankle, as may be seen in the leg coverings on an early sculpture, probably of the 2nd century, if not earlier, of the "Good Shepherd."

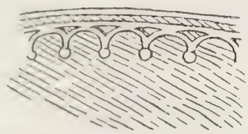
VII. But I must not detain you with these instances of antique plaitings and twistings. We have to arrive at the use of finer twistings and plaitings as they may occur in decorating edges of costume. Refined and graceful little ornaments, consisting very much of small golden and silken threads plaited to form flattened cords, appear to have been common in the early 15th century. These little ornaments are frequently indicated along the borders of dresses and robes, such as those painted by Gentile da Fabriano, Fra Angelico (Figs. 2, 3,

FIG. 2.

A sketch, with indications of ornament along neck and cuffs. From a painting of Fra Angelico da Fiesole (14th and 15th century).

and 4), and Carlo Crivelli. These names particularly occur to me as I have noted examples of the ornamented work we are considering, in pictures by them.

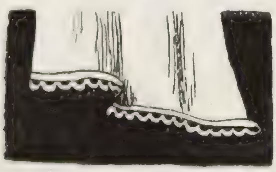
FIG. 3.



Sketch of gold thread ornament, taken from a robe painted by C. Crivelli (15th century).

VIII. About the time of these artists, that is from 1387 to 1493, the wearing of linen garments develops. While women wore linen wound round

FIG. 4.



Sketch of veil, with border of open loops, taken from a painting by Botticelli (15th century).

their heads and necks, the ends falling over their shoulders, men wore scarcely anything which we should now recognise as a collar. A minute indication of an under-linen shirt appeared above the low cut jacket, plaited, or hanging loosely from the neck.

IX. In Holbein's time, which carries us into the middle of the 16th century, the linen collar had come into fashion, as may be seen from his various portraits. Along these early collars, and also upon the first ruffs, a series of small loops, made of plaited threads, was fastened. This sort of trimming was called "purling," and is similar to the series of loops shown upon the edge of a cloth in Fig. 4. The purse of the carpenter, in the Canterbury tales, is "purled with latoun." Latoun appears to have been a sort of metal-twisted thread. The purling, in its application to collars and ruffs, then, was just the reverse of those Italian thread ornaments depicted by Crivelli and others, which were fastened on to the stuff of the dress, as in Figs. 2 and 3. The purl was open thread work, attached to the edge of a border, and was in use in the 15th century.

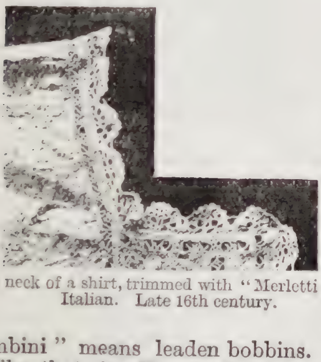
X. An interesting inventory of articles belonging to the Sforza family in 1493 contains mention of a pointed border made with "doii fuxi" two bobbins perhaps, or else knitting or hooked needles. And this pointed border has been much relied upon by different writers as being early pillow lace. I think, however, we might correctly surmise that it was a "purling." And if we may call "purling" lace, then plaited and twisted lace work belongs to the 15th century. It is, however, almost as much a lace as the bolder Assyrian and Roman fringings.

XI. We need not perhaps here dive into etymological depths for the origin of the word lace. The meaning attaching to it has like that of many other words undergone change. Long before plaiting and twisting had been applied to produce rich and varied designs, the word lace had described the plaited threads used in the manners above mentioned. And of this we have a remarkable instance in an Harleian MS. of the time of Henry VI. and Edward IV., about 1471. Directions are given in it for the making of lace Bascon, lace indented, lace bordered, lace covert, a brode lace, a round lace, a thynne lace, an open lace, lace for Hattys, and such like. The MS. opens with an illuminated capital letter, in which is the figure of a woman making these articles. But her implements are not those with which lace of ornamental quality from the middle of the 16th century and onwards has been made. A clear description is given how threads in combinations of two, threes, fours, fives to tens and fifteens were twisted and plaited together. Instead of the well-known pillow, bobbins, and pins with which pillow lace is now made, the hand was used. Each finger of a hand had the function assigned to it of serving as a peg. The writer of the MS. says that it shall be understood that the first finger next the thumb shall be called A, the next B, and so on. According to the sort of twisted cord or braid which had to be made, so each of the four fingers, A, B, C, D, might be called upon to act like a reel, and to hold a "bowys," or bow, or a little ball of thread. Each ball might be of different colour from the other. A "thynne lace" might be made, with three threads, and then only fingers A, B, C would be required. A "round lace" stouter than the "thynne" lace might require the service of four or more fingers. By occasionally dropping the use of the thread from certain fingers, a sort of indented lace or braid might be made. But when a lace of more importance had to be made, such

as broad lace for "Hattys," the hands of an assistant were required. In the quaint language of the period, the MS. tells us how we should take a fellow and set him on our right or left hand. Thus the worker would have an additional ten fingers or pegs in the two hands of his assistant. For still more important work, two assistants—one standing on each side of the worker—would be required, and so twenty pegs or reels would come into use. A process like this, involving the employment of so many people to produce an insignificant article of luxury, leads us to reflect upon the immense change which has been effected in four hundred years, not only in respect of the improved allotment of labour to willing hands, but also as regards the increased demand and consumption of trivial articles. The very idea of employing fingers as pegs, sounds ludicrous. The unfortunate men or women who passed their time in holding up their ten fingers, cannot have had as much enjoyment out of their work as that which a confirmed player at cat's cradle derives from his strings. Indeed, according to Adam Smith's opinion upon the division of labour, they "must have lost habits of exertion, and become as stupid and ignorant as it is possible for human creatures to become." Fortunately, however, in the little domain of lace-making, conditions like this were not to last long.

XII. The ingenuity of labour in producing ornaments in plaited and twisted cords, or laces, and of curling them in open loops, and such like, along linen collars and cuffs, was not lost upon designers of patterns. For soon after the publication of designs in "reticella" and "punto in aria," we find designs for "merletti a piombini" (Fig. 5). "Merletti" is the Italian for lace work, and

FIG. 5.



Part of the neck of a shirt, trimmed with "Merletti a Piombini," Italian. Late 16th century.

a "piombini" means leaden bobbins. To work design like that in Fig. 5, it is apparent that implements other than fingers, or even a series of pegs, were necessary. And since traditional practice indicates an origin of implements used, we are more or less forced into an inquiry as to the first employment of the pillow, of bobbins, and of pins, all of which must have been somewhat used for the Venetian patterns of "merletti a piombini" in the latter part of the 16th century. A cushion or pad, on which were fixed stuffs to be embroidered by the needle, is possibly as early in use as the open frame, and this latter was well known in mediæval times and even before then. But an essential of pillow-lace making is the means of holding in fixed places the little threads as they are being plaited and intercrossed according to the patterns required. This, I think, implies a necessity of pins of some sort. Now, before metal pins were in common use, we had rather the reverse of this process. Instead of the balls of thread being pendent, free to be thrown over the other, and thereby to twist and plait threads into patterns, we saw that balls or "bowys" of thread were, in the 15th century, placed upon fingers, and thus were kept in fixed position, the loose threads coming from them were plaited and twisted. But in pillow-lace making it is the loose threads from the bobbins which are fastened on to the pillow, and the bobbins, with their balls of threads, are constantly thrown about.

XIII. The process of making lace on the pillow is very roughly and briefly, as follows:—A pattern is first drawn upon a piece of paper or parchment. It is then fastened to the pillow. The pillow or cushion may vary in shape. Some lace-makers use a circular flattened pad, backed with a flat, circular board, in order that it may be placed upon a table. Other lace-makers use a well-stuffed round pillow or short bolster flattened at the ends, so that they may hold it between the knees. On the upper part of the pattern are fastened the ends of the threads from the bobbins. The bobbins thus hang over the pattern. The lace worker must be versed in the knowledge of where her fixed points are to be. These fixed points rule the way in which the plaiting and twisting shall follow the pattern. Into these points she puts her pins, as she comes up to them in the course of her work. They are, in lace of simple pattern even, so close together that a dense forest of them is soon massed into a very small compass. Without attempting to convey an idea to you of the growth of such

FIG. 6.

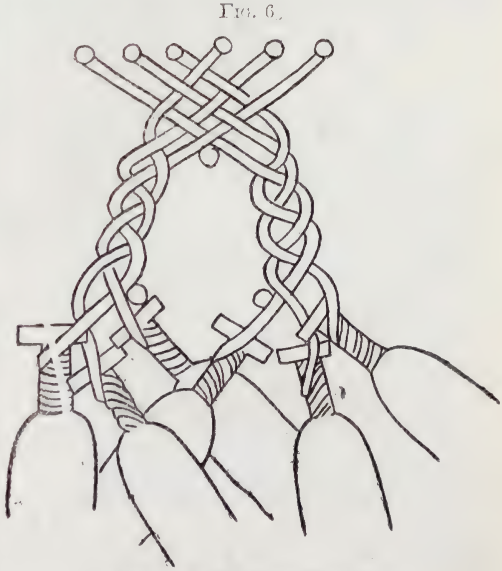


Diagram showing six bobbins in use.

a forest, I will merely take a simple form, and endeavour to show you how, say a triangle, might be worked in pillow lace. These fixed points are

mainly necessary for this—one at each angle. Around these points the lace worker would have to work her plaitings. Fig. 6 is intended to indicate this.

XIV. When you look into the minute devices, in which there are forms more complicated than a triangle, you may realise the extraordinary labour involved in pillow-lace making. This, at least, I think, is pretty clear, namely, that the method of making this kind of lace is totally different from that of needle-point lace. Yet often do we so slightly acquaint ourselves with the characteristics of our possessions, that we placidly call a piece of pillow-made lace needle-point lace, and *vice versa*. Anyone who owns a piece of lace ought to know something of how it was made. A realisation of the pains and troubles expended and caused in producing it should increase our appreciation of it. We may regret the tremendous amount of labour. Still, whether we regret it or not, a piece of lace is a record—proper or improper, but, nevertheless, a record—of labour and time expended. And expenditure of labour and time, devoted either to the production of an ironclad or a bit of lace, seems, I think, worth that recognition which a knowledge of it forces upon us.

XV. You will have remembered the "purled" edges of plaited thread and silk, and the "merletti a piombini," in making which pins became necessary. Almost coincidently with the development of the "merletti a piombini," the rapid manufacture and use of metal pins seems to arise. A few years ago, the Commissioners of Patents published some abridgments of specifications of patents. And as regards pins, some interesting facts are stated, which are worth quoting:—"Pins formed of wire seem to have been unknown in England until about the middle of the 15th century, before which time they were larger than the present pins, and were made of boxwood, ivory, bone, and some few of metal." In Richard III.'s time, about 1483, there was a prohibitory statute against the importation of pins. Queen Catherine Howard is said to have imported them into England about fifty years later, and at this time Henry VIII. sanctioned an Act to regulate the "true making of pynnes." They were to be well pointed, with heads firmly soldered on to the stems. The price of them was not to be more than 6s. 8d. (or say, about 80s. of our money) per 1,000. Though used as dress fasteners, it is evident, from their then value, that pins cannot have been at all plentiful. The manufacture of them seems to have been of foreign origin, and when once started, it developed fairly rapidly. On the Continent, in Italy, Germany, Spain, and France, perhaps, pins became almost sufficiently numerous for common use about the latter part of the 16th century. And it is at this period when I think we find that pillow-lace making commenced.

XVI. Of the history of bobbins there is not so much to be said. Little bits of wood, bone or lead, would without much special ingenuity be converted into winders for thread. The shape given to bobbins was a result of convenience in throwing the winders full of thread one over the other. An elongated shape is obviously more suited to such a purpose than a reel. An oft-quoted evidence of pillow-lace making is an engraving by a Flemish artist of the 16th century—Martin de Vos. He drew a series of plates illustrative of occupations throughout the seven ages. One of them is a girl seated with a square cushion upon her lap, apparently plaiting threads. The drawing is scarcely detailed enough to show the process of the girl's work. A pattern seems to be fixed to her cushion, and six pear-shaped weights or bobbins depend from it. It cannot, I think, be decided that these weight are bobbins. If they are bobbins they are clearly not numerous enough to work such a lace design as that which the size of the roll upon the cushion would warrant one to believe was contemplated. I rather hold to the opinion that the supposed bobbins are weights. In any case, however, aasuming that Martin de Vos has drawn a pillow-lace maker at work, his drawing is not so conclusive on the matter as are certain designs by Parasole, published at the end of the 16th century. On these is a statement of the numbers of leaden bobbins to be used for different patterns. Some require 18, others as many as 68 bobbins. Fig. 5 supplies us with a specimen of the sort of plaited and twisted thread-work of the time we are considering.

XVII. Judging from some slightly earlier specimens of nearly similar work, I think that many of the plaited lines in it were plaited separately, in lengths. When a sufficient supply had been worked, then the lengths of these plaitings might be wound round a sort of bobbin. Supplemented by a few other bobbins containing perhaps single threads, a number like 12 or 16 bobbins so charged would probably suffice for working out designs without a multitude of small metal pins. This conjecture is to some extent corroborated by specimens in which we can trace a still further use of plaited fine cords. The question, however, is somewhat involved, and without wishing to press my idea as to such a method of work, I would merely observe that four or five plaited fine cords used in combination would be but a development of the "purling," which was done with one or two fine cords interplaited.

XVIII. Before entering into the territory of white thread laces of maturer designs, I should like to make one or two remarks upon a work done with stiffened cords or even wires, which in some respects allies itself with wire filagree work. This ornamentation in stiffened cords, seems to be earlier, *quâ* importance of design, than the plaited and twisted thread-work. It was known under the name of "guipure," and was made with gimp. Gimp is a small cord made by closely whipping round a narrow strip of parchment, or a small bundle of threads, or a wire, fine threads of silk or flax, and sometimes little metal strips. It appears to have been in existence in the 15th and 16th centuries in Italy, and France, and Spain. It is an entirely different work from either needle-point, or pillow-lace making. Patterns were made by laying gimps side by side, or singly, bending them to the shape required, and then holding them together by means of little loops of thread. The stiffness of the gimp also served to retain the pattern into which the gimp might be twisted. In spite of this distinctiveness, Venetian needle-point lace, and many laces in which brides or tyes predominate, have been called "guipure." Some gold

laces are reasonably called "guipures," perhaps, though the greater portion of the gold laces extant are made after the manner of 17th century pillow-lace making, and are not therefore, as the true "guipure" is, dependent upon the ductile characteristic of gimp or wire for retaining their patterns.

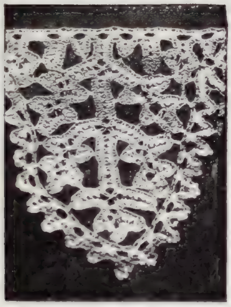
XIX. Returning to pillow-laces proper, I wish to call your attention to the way in which compactly plaited white thread lines developed into flatter lines. An early instance of this we shall see in this specimen (Fig. 7), which dates

FIG. 7.

Plaited and twisted thread-work known as "Merletti a Piombini." About 1560.

from the end of the 16th century. Another development of these flat portions of plaited work may be seen in this specimen (Fig. 8). So flat and

FIG. 8.



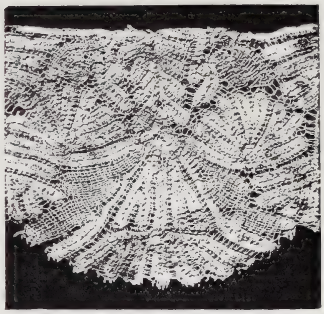
Vandyke or "Dentelle" of pillow-made lace. Late 16th or early 17th century.

close is the work here that it looks almost as though a piece of linen had been used, and from it had been cut out the various forms. However, all this is plaited and twisted thread-work done upon a pillow. Somewhat similar to this in respect of work are the *passements au fuseau* used in France in the early 17th century.

XX. You will, in the two recent specimens, have observed that the flat portions resemble narrow braids or tapes. Here is another specimen in which what might be called a tape treatment is quite apparent (Fig. 9). We have, therefore, soon come to a period in early twisted and plaited thread lace-making, when means had been devised for rendering broad and narrow forms, fine and heavy lines. In my last lecture I referred to the employment of tape for making ornamental work like lace. A specimen of tape lace, with a ground of meshes, lies on the table.

XXI. The art of pillow-lace making was not so strictly confined to geometrical patterns as was that of needle-point lace-making. Curved forms, almost at the outset of pillow-lace making, seemed to have been found as easy of execu-

FIG. 9.



Flemish pillow lace. 17th century.

tion. One reason for this, no doubt, is that the twisted and plaited work was, as we have seen, not constrained by a foundation of any kind. The plaitings and twistings gave the workers a greater freedom in reproducing designs. They could be intertwisted between the fixed points of the pattern with comparative facility, whereas, as we remember, the first needle-point lace workers began their lace with a framework of rectilineal lines. Still the pillow-lace worker did not in the matter of pattern proceed altogether faster than the lace worker with a needle. They virtually kept an even pace side by side. If anything, the pillow workers seem to owe more to the designers of patterns for needle-point lace, than otherwise.

XXII. About the early 17th century, important designs for plaited and twisted thread-work were produced. Of such I have a specimen to show you. It is a bed-cover, about 4 ft. 5 in. square. Fig. 10 shows a quarter of the design. The

FIG. 10.

Corner of a bed cover of pillow-made work. 17th century. Flemish.

design is chiefly composed of double-headed German eagles, surmounted by a Germanesque crown, and of insignia of the order of the Golden

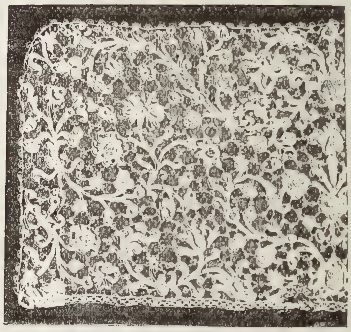
Fleece. In the South Kensington Museum it is described as being made of "tape guipure." But this clearly is a misnomer. There is no gimp in it; neither is there tape in the accepted sense of the word. Although no doubt made in separate portions, afterwards fitted and fastened together, the whole was plaited on the pillow. A revised edition of the catalogue of the lace collections at South Kensington will, I hope, shortly correct the errors I have pointed out. But there is another question of interest attaching to the existing description of this fine bed-cover. It was bought by the Kensington Museum from Mr. J. C. Robinson, who had acquired it in Spain. Its proprietor, a member of a noble family, had a history that it was of Spanish workmanship, and had belonged to Philip IV. of Spain. Decorated bed-covers were in the time of that king much affected by wealthy Spaniards. But this fact, and the legend, have not convinced me that it is of Spanish workmanship. Because Frenchmen like Stilton cheese, and because we can buy good Stiltons at Chevet's, in the Palais Royal, we don't decide that Stiltons are made in France. In my first lecture I quoted incidents strongly tending to show that Spain had never been a country of importance in the making of lace—at least, at so early a date as that of this bed-cover. Spain published no lace pattern books. Her archives are replete with records of imported laces. She appears to me to have been as a great political and commercial power, unlike artistic and industrious Italy and Flanders. She may have been more like France, though perhaps less artistic; and France, even in the early 17th century, had little prestige in making laces. France later on acquired a renown, when she, or rather her King and Minister, established lace-making centres. I have not yet found out that Spain took analogous steps towards promoting the art of lace-making. Indeed, as times went on, her political and commercial power declined with apparently no immediate compensating resurrection of artistic industry. Now, Flanders and Spain, during the 16th and part of the 17th centuries, were under one Government. From Flanders, or as they are called Spanish Flanders, Spain imported most of the laces she wanted. Looking to the excellent completeness of this bed-cover, it seems to me to have internal evidence of being the work of Flemish lace-makers. Had it been of Spanish workmanship we should surely have had other specimens more peculiarly Spanish. And we might have expected to have heard of distinct Spanish laces, just as we have Points d'Alençon from France, Valenciennes, Mechlin, and Brussels laces from Flanders, and Honiton from England.

XXIII. For reasons slightly like these I have given in respect of Spain, not having been a lace-making country of importance, I am disinclined to believe in the well-known record, that a native of Nuremberg, Barbara Uttmann, invented in 1561, pillow-lace making. Her tomb in the churchyard at Annaberg, is a construction apparently of the present century. The people who erected it have inscribed upon it, "Here lies Barbara Uttmann, died 14th January, 1575, whose invention of lace in the year 1561 made her the benefactress of the Hartz Mountains." The sort of work which she is said to have made and taught to the people was a species of knitting. She was assisted in this by certain refugees from Flanders. It is quite possible that she may have made some sort of purling or even little borderings and insertions like the "merletti a piombini" of the Venetians. But since the Venetians directly influenced the Flemish, Barbara Uttmann's adoption of Flemish work can, I think, hardly be called an invention. I mention this point in connection with German laces, which by the way have not acquired any artistic reputation, since an idea seems to have got about that Barbara Uttmann was an original inventress. Early Flemish edgings are similar to the Venetian "merletti a piombini."

XXIV. We need perhaps trace the development of "brides" or tyes and other details in pillow-lace making. The history of them would be similar to that I gave in respect of needle-point work.

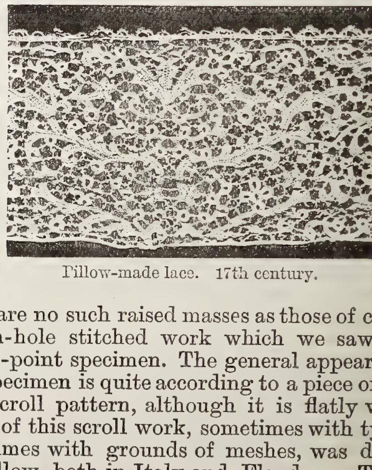
XXV. As I have before remarked, design in pillow lace very much followed that in needle-point; and this we may see by comparing these two specimens (Fig. 11 and 12). In both specimens we have the scrolls held together by tyes. The tyes are ornamented with little "picots," or loops, and fillings-in, or "modes," are noticeable in both. In the pillow lace (Fig. 12), however, there are no such raised masses as those of compact button-hole stitched work which we saw in the needle-point specimen. The general appearance of this specimen is quite according to a piece of Venetian scroll pattern, although it is flatly worked. Much of this scroll work, sometimes with tyes and sometimes with grounds of meshes, was done on the pillow, both in Italy and Flanders. The last

Fig. 11.



Venetian needle-point lace.

Fig. 12.



Pillow-made lace. 17th century.

specimen I showed you may, perhaps, be Italian. Here, however, is a specimen (Fig. 13) presumed to be Flemish. A great deal of this sort of lace

FIG. 13.

Pillow-made lace, "à brides." Flemish. 17th century. Sometimes called "Point d'Angleterre."

was imported into England in the middle of the 17th century, and went under the name of "Point d'Angleterre."

XXVI. The real English lace of this time was commonly known as bone lace, and was apparently so-called because it was made with bone bobbins. It was a lineal descendant of the "purling" of Chaucer's time, and the plaited and twisted thread trimming to Queen Elizabeth's ruff. We may see border lace, probably bone lace, sculptured on the tomb of Lady Doodridge, at Exeter, and upon other monuments of the 17th century elsewhere. Such lace was allied in style of make and design to the Venetian "merletti a piombini." Bone lace was the name by which most English pillow lace made during the 17th century was known. In Charles II.'s time its manufacture was of sufficient importance to demand Parliamentary attention. We had been influenced by Flemish pillow laces, and were, no doubt, doing our best to imitate them. But our English imitations were not fine and artistic enough to please noble and wealthy people, who accordingly, as in other countries, obtained their supplies of lace from abroad, and chiefly from Flanders. Still it was thought wise to stimulate our bone-lace manufacture by stringently prohibiting importations of Flemish lace. To evade these stringent prohibitions, and to enable English lace dealers to supply the country with the esteemed Flemish laces, or as they had been called, "Points d'Angleterre," our manufactures obtained the services of Flemish lace-makers, and induced some to settle in England. This took place about 1662, a date which closely corresponds with the time when France, by the help of Venetian *employés*, was establishing her lace-making centres. France, however, more under paternal government than constitutional Parliamentary England, seems to have been the more successful of the two countries in obtaining celebrity for her newly adopted industry. "Points d'Alençon," I am afraid, have always been more prized than Honiton pillow lace. Bishop Berkeley in the early 18th century makes a remark upon the relative values set upon English, French, and Flemish laces. "How," he asks, "could France and Flanders have drawn so much money from other countries for figured silks, lace, and tapestry, if they had not had their Academies of Design." England has, however, now gone beyond France in the number of her Schools of Art, and through a solid progress of imperial and local co-operation she may soon be able to boast of a larger number of provincial museums, which in an important sense may become academies of design for the benefit of our manufactures.

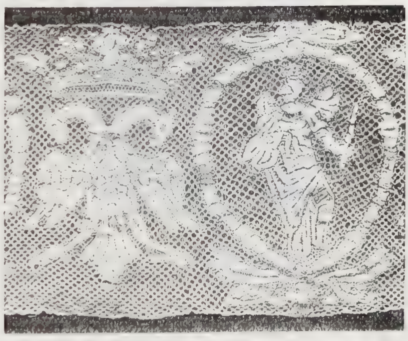
XXVII. But we must return to our inquiries as to the development of pillow-lace making. We were particularly discussing pillow-made scroll designs held together by brides. Turning to pillow laces with grounds of small meshes, I have here a specimen of such work, and one in which a floral and more naturalistic treatment is noticeable (Fig. 14). Of about the same period—that is, I

FIG. 14.

Pillow-made lace, "à réseau." Flemish. 17th century.

think, near 1660—we have pillow laces in which other ornaments, such as heraldic devices and figures, were introduced. This (Fig. 15) is, perhaps, an Italian pillow lace of this period.

FIG. 15.

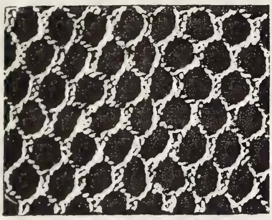


Pillow lace, with ground of meshes. Italian or Flemish. 17th century.

XXVIII. On the table are examples of Italian pillow lace, with a scroll pattern of conventional drawing, done with a ground of meshes. I am afraid that time will not allow me to trace the development of the various plaitings used at different lace-making centres for the meshed grounds or *réseaux*. Generally speaking, I do not think that these *réseaux* came to be made before the

17th century. The Flemish makers appear to have excelled in producing them; and there are three important classes of them which I will now proceed to show you. We may take the Mechlin first. Mechlin, as a lace-making centre, dates from early in the 17th century, at least. Here are two specimens of characteristic Mechlin laces; the one with a close design, in which appear boys blowing horns, and carrying bows and arrows, is in the style of Louis Quatorze ornament, while the other, with a ground sprinkled with little roses, is some 70 or 80 years later. A feature in Mechlin lace is the thread or *cordonnet* which outlines the pattern; and another is the particular plaiting of the threads forming the meshes (see Fig. 16). When a

Fig. 16.

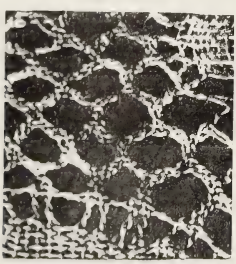


Enlargement of meshes in Mechlin lace grounds, showing the two plaited and four-twisted sides in each hexagonal mesh.

cordonnet and this sort of mesh appear in a pillow-made lace, it is safe to consider the lace to be of Mechlin manufacture.

XXIX. The second of the important pillow laces is the Valenciennes. I will show you the meshes first of all. You here observe that the threads composing the sides of the mesh are plaited (see Fig. 17). No sides, as in the Mechlin

Fig. 17.



Enlargement of meshes in Valenciennes laces, showing the plaiting for all sides of the mesh.

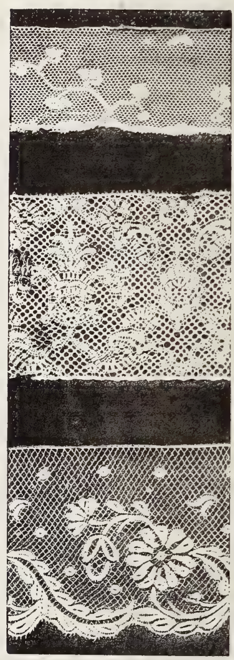
meshes, are merely of twisted threads. No outlining thread or *cordonnet* is used in Valenciennes lace. The pattern is flat, as you see it in this specimen of late 17th century. (Fig. 18.) This Fig. 19*a* is a specimen of later date, after the middle of the 18th century, when the patterns for lace consisted of flowers and buds sprinkled upon the ground, as we saw it, not only in the Mechlin lace, but also, during our last lecture, in designs for Point d'Alençon. The second specimen 19*b* might be called a piece of "Fausse Valenciennes." The work is less regular, and the meshes are differently plaited. The third specimen, 19*c*, is a piece of present century Valenciennes lace, made probably at Ypres, and is a much more wiry and less soft-looking

Fig. 18.

Valenciennes pillow lace.

lace than the old "Vraie Valenciennes" of the 18th century. An interesting example of a French lace, done in the style of Valenciennes, with ill-drawn

Fig. 19.



a Pillow lace. "Vrai Valenciennes." Late 18th century. French.

b Pillow lace. Valenciennes. Early 18th century. French.

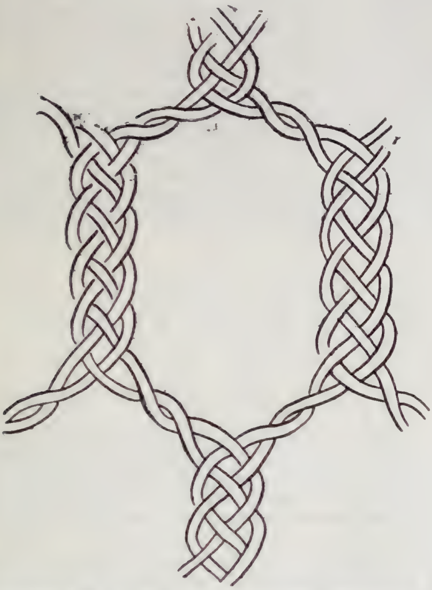
c Pillow lace. Valenciennes. Made at Ypres. Flemish.

Scripture figures and legends, lies on the table. There are indications that the date of its production was about the first ten years of the 18th century.

XXX. Now a third important pillow-made lace is the Brussels. In Brussels laces we find many sorts of designs. Some are placed on a groundwork of brides, others upon meshes. The plaiting of the meshes of Brussels lace is different from that of either Mechlin or Valenciennes (see Fig. 20). The plaited side of a Brussels mesh is longer than that of a Mechlin mesh, otherwise these two latter sorts of meshes are much alike. But a further distinctive mark of Brussels pillow lace is the

raised plaited *cordonnet* or edging which marks the patterns. This you might notice in this specimen (Fig. 21*a*). This piece dates from about

Fig. 20.



Enlargement of mesh of Brussels ground, showing the four-twisted and two-plaited sides in each mesh.

the commencement of the 18th century, and the pattern is remarkable as being a pillow-lace rendering of an Alençon design. The second specimen (Fig. 21*b*) is of the same period. It is a mixture

Fig. 21.

a.

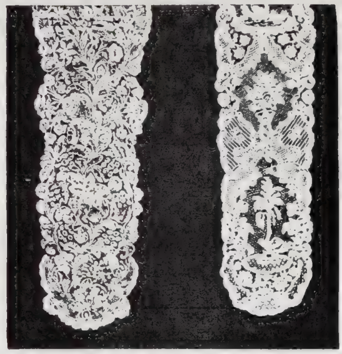
b.

Pillow lace. Brussels. 18th century.

Needlepoint and pillow lace. Brussels, 18th century.

of needle-point and pillow lace. The details are worked with a needle and the ground is of pillow make. The two specimens shown in Fig. 22 are portions of lappets. Fig. 22*a* is again an example of an adaptation of a Point d'Alençon pattern rendered in pillow lace. The rough indications of the variety of devices introduced into this lappet do poor justice to the extremely elegant manner in which the threads themselves have been plaited to represent the forms of flowers, birds, variegated

Fig. 22*b*. Fig. 22*a*.



Lappets of pillow-made lace. Brussels. 18th century.

"modes," &c., actually shown in the original lace. The second lappet (Fig. 22*b*) is of close floral design, and this close arrangement of flowers and leaves, broken by small interspersed mesh grounds, has been considered to be a mark of early Devonshire lace. But the workmanship is precisely like the Brussels lace, and I am inclined to assign to such piece a Brussels rather than a Devonshire origin.

XXXI. Of the various methods used by Brussels lace-workers in executing portions separately, of bringing them and fixing them together to form a whole piece, as well as of the many combinations of needle-point and pillow-lace making, I am sorry not to be able now to speak. Such details would, if justly treated, supply matter enough for a separate lecture. The specimens upon the table are a small index of the variety of patterns worked by the Mechlin, Valenciennes, and Brussels pillow-lace makers, and some of them are, as you will see, of beautiful finish in workmanship, as well as of intricate design.

XXXII. My object this evening has been to place before you a summary of incidents respecting lace made on the pillow, and I hope I have to some extent shown you that it is a branch of the art of lace-making originating from a source different from that of needle-point lace-making, and yet, in the progress of its design and pattern growth, becoming much allied with that of needle-point lace.

MISCELLANEOUS.

ON A NEW SCREW GAUGE FOR ELECTRICAL APPARATUS.*

By William Henry Preece, F.R.S.

It is very desirable to establish a gauge for the manufacture of various small screws used in the construction of telegraphic and electrical apparatus. Sir Joseph Whitworth, in England, and the Franklin Institute in America, have done this for the bolts and screws used in mill-work and engineering generally, but no one has extended either system to the finer work used in those numerous practical applications of electricity that are

* Read before the British Association, at York, Sept., 1881.

now becoming so important. Gauges and screw-plates are now as numerous as the makers engaged in the trade. Nettlefold's sizes of screws are, perhaps, those best known, but they are worked to a special gauge, starting from a diameter of 0·5 inch, which is numbered 32, and which has no known relation to any other gauge used in telegraphy. Whitworth's standard gauge for watch and instrument makers has not yet been adopted. The microscopical gauge is confined entirely to microscopes. There is, in fact, no fixed pitch, no form of thread, no recognised number of threads per inch, no gauge based on practice and experience. Hence interchangeability for repairs is impossible, and the difficulty of applying for materials from abroad becomes very great. Screws are now generally supplied as "per pattern."

Sir Joseph Whitworth has remedied these defects in the larger forms of machinery, and, at the present moment, there is not a ship in her Majesty's Navy which is not supplied with the same screws and the same threads. Many large engineering works, such as those at Crewe, are in the same happy condition. Sir Joseph Whitworth carried his proposed standards for taps and dies to ·100 inch diameter, having 48 threads per inch, but his gauge has not come into general use for sizes less than ·250 inch diameter. I have placed myself in communication with most of the principal electrical apparatus manufacturers in England, and they have not only expressed their willingness to accept a well-conducted gauge, but have concurred in the view I have indicated of the present unsatisfactory condition of the question.

It fortunately happens that, from the point where Sir Joseph Whitworth and the Franklin Institute start in one direction, we can move in the opposite direction, so that, not only can the two gauges be made continuous, but though necessarily different in their applications, they can really be made uniform in their character. Indeed, the Whitworth gauge might itself, with slight modification, be extended.

It is only necessary for us to consider angular threads; square threads do not enter in such small work.

The Whitworth gauge specifies that the pitch of angular threads shall be equal to the depth which involves an angle of 55°, and that the top and bottom shall be rounded off to $\frac{1}{6}$th of the depth.

Screws of a diameter of $\frac{1}{4}$ in. (or No. A in the B.W.G.) have twenty threads to the inch. This is the starting point of the American gauge, and both deal with increasing diameters. I propose to start from the same point, but to work in the opposite direction, dealing with diminishing diameters. Thus my starting point is of the new No. 4 centimètre gauge, ·251 in. diameter, having twenty threads to the inch.

The exchange of apparatus between this and Continential countries is now so general, that the adoption of the French decimal metrical system is well worth serious consideration. This is felt so much that in nearly every table of wire gauges the dimensions both in parts of inches and metres are given. The adoption of the metre as ths unit length would secure adoption of the gauge abroad. The use of the inch as a unit leaves us in that singular insular position, to which Sir William Thomson pointedly referred in Section A. the other day.

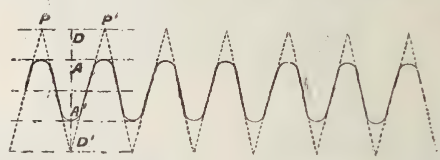
There are two dimensions besides the form and nomenclature to be considered, viz., the diameter of the screw and the number of threads per unit length. I suggest that the nomenclature be that of the wire gauge. The form I again refer to.

For the first dimension we might adopt a special number, as is done in the trade now, or we may take the same number for the screw and its diameter in *mils* or in millimètres, or, as I propose, we should adopt the new centimètre gauge recommended for adoption by the committee of the Society of Telegraph Engineers (December, 1879).

For the second dimension I propose to take the 5th multiple of the number of the screw in the new centimètre gauge as a factor. Thus No. 5 screw will have twenty-five threads to the inch, and its diameter will be ·225 in. No. 8 screw will have forty threads to the inch, and its diameter will be ·161 in., and so on, as shown in the attached table, which embraces nearly all the screws now in use. In all other gauges the number of threads per inch is perfectly arbitrary. In fact, at present, even with the same gauge and the same kind of screw, the number of threads per inch varies.

Thus, if there is any value in my suggestion, we should have a simple nomenclature and a fixed gauge based on that already adopted for wires and plates, and easily remembered.

The attached diagram gives an idea of the character of the thread recommended by me for consideration. It has been carefully prepared with existing threads, and



due regard has been paid to the essential requisites of strength, durability, and friction, but, in the opinion of some, the depth of the thread is too deep in proportion to the diameter of the screw. In the small screws used for telegraphic and electrical purposes we need not consider the difference of metals employed.

There can be no doubt that a recognised gauge, with a distinctive name, based on a simple method, and easily remembered, and supplied by such a house as that of Whitworth will soon take root, and be generally accepted, if stamped with the requisite authority.

I submit that the subject be referred to a committee of this Section for consideration and examination, so that a new gauge may be recommended for adoption, with all the authority of the British Association.

PROPOSED TELEGRAPH SCREW GAUGE.

Gauge.	Threads per Inch.		Diameter.	
	Whitworth.	Telegraph.	Inches.	Millimètres.
4	20	20	.252	6·4
5	24	25	·225	5·7
6		30	·201	5·1
7	..	35	·180	4·6
8	32	40	·161	4·1
9	..	45	·144	3·7
10	40	50	·129	3·3
12	48	60	·103	2·6
14	..	70	·082	2·1
16	..	80	·066	1·7
18	..	90	·053	1·34
20	..	100	·042	1·07

Patents in Turkey.—General Patent-laws have been lately passed and promulgated in Turkey and Liberia. The Turkish Patent-law is substantially a copy of the French and German systems. Any person may take a patent on deposit of drawings and specifications. Longest term of the patent fifteen years; annual tax, 18 dollars. The invention must be worked within two years from the date of the patent. The penalties for infringement and the proceedings are the same as in European countries. In Liberia the patentee must be the inventor, or must have lawfully acquired the invention from the inventor. Drawings and specifications must be furnished. The Government fee is 50 dollars. The invention must be worked within three years after the grant of the patent.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE ART OF LACE-MAKING.*

By Alan S. Cole.

Lecture IV.—Delivered May 9th, 1881.

Résumé as to styles of design in hand-made lace. Traditional patterns. Sketch of the development of inventions for knitting and weaving threads to imitate lace. Differences between machine and hand-made laces. Modern hand-laces at Burano, Bruges, Honiton, &c.

I. This evening, in my concluding lecture, I propose to take a passing survey of a few of the principal topics in the history of the art of lace-making, to which I have called attention.

II. In tracing the history of the two great divisions of lace-making by hand, needle-point and pillow, I have sought to establish a gradual development of the art, rather than to insulate it by itself, and to regard it as some freak of handicraft of unaccountable spontaneous birth.

III. Needle-point lace-making is distinctly a child of embroidery; pillow lace-making, a lineal descendant of plaited thread-work and fringes. Both chiefly owe such fame as they have acquired to the beauty and variety of form imported to their productions by the genius of designers of patterns. When artists considered free threads (looped, plaited and twisted) as a fitting vehicle for representation of patterns, a higher career for the employment of looping, plaiting, and twisting commenced. This career shows first signs of development in Venice early in the 16th century. From Venice, fancy, fashion, imitation, and other such ever lively influences, spread the newly-developed white thread-work to other countries. In each country where the art happened to become implanted, the special circumstances of the various people gave it some sort of character, either in a strong or a weak degree.

IV. Thus, the laces of Flanders, in their first stages of growth linking themselves to those of Italy and Venice, later on are entirely different in appearance from their ancestors. This is particularly so as regards the Valenciennes, Mechlin, and Brussels pillow lace. French needle-point laces, again, have, as we have seen in the Point d'Alençon, a specialty in appearance which, without the gradual steps by which we have traced them from the "Punt in aria," might be said to have no likeness to their antecedent Venetian parents. English laces, on the other hand, are not so markedly detached from the general family. On the whole, they closely resemble Brussels, Mechlin, and Valenciennes laces, though at the same time Honiton lace, with its prettinesses of floral devices, may claim to stand by itself. In respect of other countries, the methods of making lace are similar to those involved in one or other of the categories above specified. The designs of such laces are either direct imitations of older laces, or else are of so unmarked and general a character as to lose themselves in the primitiveness of design, which may be said to be the common property of all form-depicting countries.

V. I have prepared a diagram to show, in a general manner, the periods of different styles of patterns you will observe black bands of varying size. The first one is intended to indicate the growth and in lace-making (Fig 1, p. 800). These extend from 1540 to the present time; and I have roughly divided them into seven epochs, some of them overlapping, preceding, and succeeding ones. Upon the diagram progress of needle-point lace-making; the second, that of pillow-lace making; and the third, that of machine-made lace.

VI. In respect of hand-work, I think needle-point lace developed itself sooner than pillow-made lace. But the difference in data is possibly so slight as not to be worth close inquiry. Needle-point, at starting, took the stronger growth of the two perhaps. It seems to have reached a climax from between 1650 to 1720. Then it declined, and from 1790 to the present time it seems to have preserved an even life. It is not of such strong life as that of either pillow-made or machine-made lace. As regards pillow lace, it appears to have expanded in vigour, as needle-point declined, so that its period of supremacy might be placed at from 1680 to 1780. From 1790 to about 1850 the annual quantity of pillow-made lace became smaller perhaps than formerly, but soon it revived, and now seems to be larger. As to machine lace, that may be said to have begun its life with the machine-making of nets about 1770, and in a hundred years to have become probably more than a hundred times as important in quantity as needle-point and pillow lace combined.

VII. We have discussed, principally in their respective classes, those laces which have celebrity for beauty of pattern, as well as for fineness of workmanship. And we have seen that these come from Venice, Alençon, Valenciennes, Mechlin, Brussels, and I think it would be unpatriotic if we did not add Honiton. But, now, we should give a share of attention to other less celebrated laces, and I will therefore show you a few specimens of them. Of German provincial laces—evolutions, as we may take them to be of Barbara Uttmann's 16th century work—there are two pieces, both from the district of the Erzegebirge (Fig 2, p. 801). Although made recently, the patterns displayed in these laces might almost be of any date. They are, evidently, traditional patterns, handed down through generations of lacemakers, without much modification since the time when they were first made, which was, probably, in the 17th century. The upper specimen, with its large circular device and

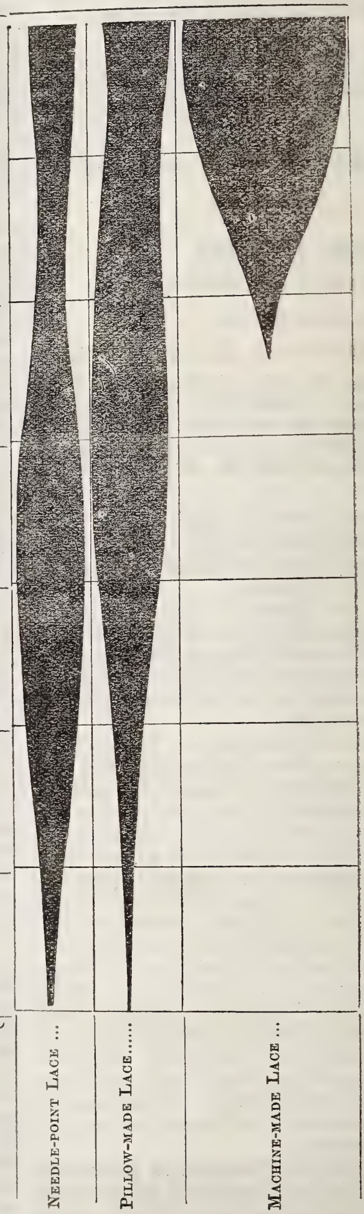
* The right of reproducing the illustrations is reserved.

quaint plant form, is similar to some lace made in Holland. The lower is what would be called a sort of "torchon" lace. The principles of design in this are simple, the pattern consisting of various lozenge shapes. It is not unlike that used by the peasants of Dalecarlia, in Sweden, who, for some hundred and fifty years, have made this sort of lace, only in coarser thread than that used by the Germans.

VIII. Patterns, somewhat similar, have been used by the inhabitants of the Island of Crete. There is a large collection of Cretan laces at the South

FIG. 1.

	I.	II.	III.	IV.	V.	VI.	VII.
DATE	1540 TO 1590.	1590 TO 1630.	1620 TO 1650.	1650 TO 1720.	1720 TO 1780.	1790 TO 1851.	1851 TO 1881.
STYLE OF PATTERN ...	Geometrical forms as worked in Reticella and Punt in aria. No "bride" or meshed ground used.	Introduction of floral and human forms, and slender scrolls, held together by "brides" or tyes.	Development of scrolls, and elaboration of details in scroll patterns. Commencement of use of meshed grounds.	Arrangements of detached ornamental details. More naturalistic imitation of flowers and pictorial representation of figures and portraits, and considerable use of ground of small meshes.	Designs composed of small details sprinkled over meshed grounds, and perpetuation of preceding patterns of 1690 to 1720. Use of machine made net commenced about 1720.	Perpetuation of some few traditional patterns, and mixture of conventional and naturalistic details. Repetition of motives. Loss of freshness in design.	Production of designs especially considered in regard to their reproduction in machine laces. Revival of old patterns. Mixture of all preceding styles.



Kensington Museum. Little, if anything, is known of the origin of lace-making there. It has a likeness in many respects to the quaint pillow laces of South Italy. Crete has been intimately connected with Venice, and very probably Cretans learnt the art of lace-making from Venetians and other Italians. The workmanship displayed in these Cretan laces is remarkable. The ability to plait and twist threads is almost as good as that of artistic lace-makers at Brussels and Mechlin. The Cretan laces are chiefly of silk. The patterns in the majority of the samples at the South Kensing-

ton Museum are outlined with one, two, or three bright coloured silken threads, which form the *cordonnet* of the lace. As a rule, the motives of the Cretan lace patterns are traceable to orderly

FIG. 2.

German pillow-made laces. 18th century.

arrangement and balance of simple symmetrical and geometrical details, such as diamonds, triangles, and odd polygonal figures. Sometimes the patterns owe their origin to untutored imitation of a blossom or leaf. Here are two specimens of the Cretan lace (Fig 3, *a b*). I have specially selected

FIG. 3.

Pillow-made laces from South Italy (18th century), and from Crete, Early 18th century.

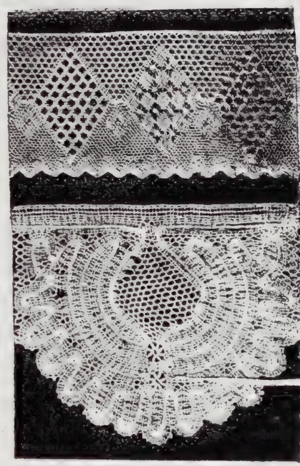
one of the more ambitious of the Cretan design, that in which we have a line of stately figures, holding hands, strongly suggestive of those delightful persons which are cut out of paper for infantile delectation. The specimen beneath is of silk. Lace, I believe, is no longer made in Crete. The specimen in which two birds appear, together with forms, the meaning of which I cannot elucidate, is of South Italian lace (Fig 3 *c*).

IX. From Italy we may cross Bohemia, and place ourselves in Central Russia. Pillow lace has been made there for over a hundred years, by peasants of different districts. Following in the wake of fashion of Western Europe, Russia, under Peter the Great, towards the end of the 17th century, took up with lace-making. A silk lace factory was then established, but no cultivated artistic spirit ever raised the productions of this factory to special distinction. The patterns now used by Russian lace-makers bear all the stamp of traditional provincial patterns used by different European peasantries. Lace is made in Russia in the districts of Belev, Volozda, Riazan, and Mzensk. This scalloped border (Fig 4 *a*) is made in the Beler district. Its

FIG. 4.

b

a



Russian pillow laces. 19th century.

big meshed ground is plaited similarly to Italian and Valenciennes grounds. The border (Fig 4 *b*) with small vandyked edge reminds us of the style of German and Swedish "torchon" lace. It is also suggestive of a lace made a few years ago at Ripon, in Yorkshire.

X. Thus, over a great area in Europe, we may judge how lace-making of nearly uniform style of design has spread itself. It is a humble and rather precarious means of support for peasants, and in this condition it cannot be expected to rise to any status of artistic importance. Sometimes a little stimulus is given to the efforts of one set of peasants, sometimes to another, as for instance, at the present time, when fanciers of hand-made lace purchase in fairly considerable quantities trimmings and borders of Russian lace.

XI. From specimens, the origin of which is identified with various countries, we may pass to lace-makers themselves, their training to the

practice of the art, and a few of the circumstances of their practice.

XII. The name manufacture seems at once to call into view smoky towns with lofty many-storeyed buildings, high chimneys, roaring furnaces, belching steam-engines, and crowds of busy workmen. In such places we may, in a single great house, pass from masses of raw material, and, traversing a series of rooms, note in each, perhaps, some phase in the metamorphosis of, say, clods of damp clay into stores of hard clear-glazed vases, cups, saucers, and such like, or of pigs of iron into workmen's utensils and complicated machinery.

XIII. Now, as regards lace made by machinery, the process of converting the raw material into a length of lace is not so complete as either of the two instances above referred to. Threads used for lace are made in a manufactory distinct from the lace manufactory. A like arrangement exists in respect of hand-made laces, that is to say, that the lace-worker is not also her own spinner of thread, though three hundred years ago, the spinner of threads, with her distaff and wheel, would sit in the same room with the needle worker; but this association of two separate employments in time was broken up, and division of labour, a subject full of interest, and ultimately connected with the development of organisation in respect of manufactures, arose.

XIV. The present position of lace-workers does not appear to differ very materially from what it always has been, and some interesting facts concerning it have been kindly supplied by Mrs. Percy Smith, in regard to Belgian pillow-lace workers at Bruges. Lace there is made by children and by adults. The children begin work in convent schools, when they are as young as five or six. They first make a small "torchon" lace, smaller and less elaborate than specimen in Fig. 4*b* (p. 801), but of that character of work, in which you will not observe any subtleties of "modes" or fillings-in, like those we saw in the fine specimens of Brussels lace exhibited last Monday. Many of the young Belgian generation of artisan children are thus, early in life, grounded in the art of lace-making. This grounding takes up a principal part of their school-time, for whilst two hours a day are given to reading, writing, and arithmetic, the remainder of the day is devoted to lace-making. In a few parish schools, which are distinct from convent schools, lace-making is taught, but in a lesser degree than in the convent schools.

XV. As regards the class of lace-making women, the work by them is done in their cottages in the town. In summer you may look down long and wide back streets of the town, and see hundreds of women in groups of three, four, and five outside their cottages plying their bobbins most industriously. In winter if you walked down such streets you would find the women at work, sitting by the windows indoors. It is estimated that there are over 1,000 lace-makers at Bruges, and of these many, doubtless, help to sustain Bruges in her mediæval reputation for pretty faces. Lace-makers have to be careful of their hands, as roughness in the skin is liable to make the lace yellow-looking and dirty, a factor which considerably depreciates its value, hence lace-makers cannot also follow agricultural pursuits. The picture of these lace-workers at Bruges very much resembles that given by Bishop Berkeley in the 18th century. When he speaks of English labourers in the South, he says, "on a summer's evening, they sit along the streets of the town or village, each at his own door, with a cushion before him, making bone lace, and earning more in an evening's pastime than an Irish family would in a whole day."

XVI. To return, however, to Belgians of the present day, the laces made are collected for the merchants, whose agents, on market day, sit in little boxes, like ticket offices, in the market place. To these the makers bring their laces, which are received and paid for by the agent. At the same time, the agent gives to the worker fresh orders, and serves out the pattern to be done. Every pattern, after it has been worked, has to be brought back to the agent, under penalty of a heavy Government fine, which thus is a protection for designs.

XVII. Now, as regards the design, you may remember how much a good rendering of pattern depends upon the skill of the pricker, who determines where the pins are to be placed as the twisting and plaiting proceed. In convents, the instructors usually undertake to prick the patterns; but for the other body of lace-makers, the pricking is done (at least, in Bruges) almost entirely by one woman, whose renown as a pattern pricker is such, that, at the present time, she has commissions which will take her eighteen months to execute.

XVIII. Coming now to thread used by the workers, it is a curious fact that, although the flax is grown in Belgium, the twisting it by machinery into fine threads is done in England. The thread, when made, however, is not found to be a pure flax thread, for there is a slight admixture of cotton with it; and this imparts a measure of hardness to the lace, a detrimental quality which earlier laces, made with hand-spun thread, do not, fortunately, possess. When lace-makers have to use hand-spun thread, they obtain it from the town of Alost, where Belgian spinners make the thread. This purer and softer thread is used for the better qualities of Belgian needle-point lace, specimens of which lie on the table. Work of such sort is done to special order; and its price, £12 to £15 per yard for widths of four or five inches, renders it scarce.

XIX. I now wish to offer you a few remarks upon styles of patterns used in the United Kingdom. The laces of Buckinghamshire and Devonshire stand first perhaps amongst English laces. Here is a figure (5, p. 803), showing three sorts of Buckinghamshire lace. In the first one (*a*) we may notice a variety of fillings in. This variety gives the name of Trolly lace to such specimens. It is of 19th century work, but an adaptation of Mechlin "Trolle Kant," or sampler lace, sent round to dealers and purchasers to show the variety of patterns which the lace-makers happened to be engaged upon. The other two specimens (*b*, *c*) are also of Buckinghamshire workmanship, and like the first, are clearly indebted for patterns and general style to Flanders.

XX. Lace made in Devonshire, at Exeter, Honiton, and elsewhere, is very much in the style of Brussels laces. The little separate sprays of flowers worked on the pillow, and then sold for application to net, &c., have become celebrated to some extent. A naturalistic treatment in the drawing of the flowers, and leaves, and insects, which appear in

so-called Honiton guipure, or pillow lace with ties, is a distinguishing characteristic of this class of English lace. Sometimes a costly specimen of Honiton lace is made for a special purpose, and

Fig. 5.

English pillow laces. 18th century.

then, according to the requirements of the person who may have ordered the work, the lace is made with better care than usual. Of such works we have two important specimens, lent by Messrs. Hayward and by Messrs. Howell and James.

XXI. Although private enterprise and courtly patronage have essayed, and to an extent succeeded, to implant the art of lace-making in the United Kingdom, and although from time to time direct foreign influences have been infused into it, as by refugee Flemings in the 17th century, a practice of the higher ornamental phases of the art has never fairly and successfully rooted itself here. Before artistic lace-making had fairly developed in the later years of the 16th century, England had been gradually slipping away from Papal supremacy. Convents and monasteries, in which branches of fine art have ever been fostered, almost disappeared from England, and no institutions so strict for artistic and disciplinarian purposes succeeded to them. To a cause like this we might assign the failure of England to become a leading producer of lace. A Frenchman, who wrote in 1852 upon lace-making, gives, however, a different cause, which is amusing. Granting that if the product of all products, requiring grace in its development, be lace, how, he asks, is it possible to find grace in England? Do you want proof of this, writes this Frenchman? Look, then, at an Englishman walking; look at him when he makes a bow; look at him as he takes a seat, as he enters a room, as he hands a cup to anyone, and so forth. The conclusion clearly is that the Frenchman was right—we were awkward, we had no grace, and so were incapable of making good lace. But now, remembering that such observations were made thirty years ago, when England, "perfidious Albion," was in her final stage of perfidy towards France, it will not surprise us much to find a vast and admitted improvement in regard to much of our lace-work. In the matter of machine lace, a subject we shall shortly touch upon, we may boast of as good quality of design and workmanship as exists anywhere; while for our hand-made laces, the specimens of Honiton pillow lace and Irish needle-point lace are surely re-assuring to anyone who is doubtful of British powers in this art. At the same time, in speaking of this Irish needle-point lace, called "lacet," I must tell you that the greater part, if not the whole of it, is produced in Irish convents. Of other Irish laces I may say that there are about eight so-called different sorts. But Limerick lace is a tambour embroidery, I think; Carrickmacross lace is a sort of cut muslin work; pearl tatting, or "Frivolite," is clearly neither genuine pillow nor needle-point lace, and the varieties of crotchet imitations do not of course belong to either of the two important branches of the art.

XXII. Some thirty odd years ago, Parliament voted money for the encouragement of normal schools for lace-making in Ireland. From causes which do not require discussion, the Governmental encouragement was withdrawn, after having existed for some ten years, and the schools are now closed.

XXIII. Lace is made by Irish peasants in their cottages and cabins. They work chiefly from traditional patterns. No inspection for instructive purposes, or for suggestion of new patterns is provided, save such as may be derived from the relations between lace-dealer and lace-maker. The peasants are left somewhat to their own devices, and so one does not look for much artistic work from them. The better Irish lace—lace which may rank with lace of the finer classes altogether—comes from the convents, where fine old patterns and well selected new designs can be re-produced.

XXIV. Returning once more to the Continent, we shall find, in France, Austria, and Italy, a considerable life in the making of lace by hand. It is a popular fancy to suppose that the art is dead. The patronage which the wealthy can and do accord to the art, stimulates the production of new works, and while such patronage is intelligently and discriminately extended, the art lives.

XXV. From Vienna come occasional specimens of needle-point lace-work. The extraordinarily fine collar of needle-point lace, a modern version of the raised Venetian Point of the 17th century, lent by Mrs. Alfred Morrison, was, I believe, made under the direction of a Viennese lace merchant, who employs Bohemian lace-makers. Putting aside the question of design, which in this over-elaborated collar has not the dignity of an Italian 17th century raised scroll point, you will see here an astounding combination of almost incredible minutiæ, executed with a perfection of

finish which rivals that displayed in earlier work. Needle-point lace is also made in France, exceptionally, perhaps, but still sufficiently to show that what has been done can be done again.

XXVI. In Italy a new departure has been taken in the making of hand-made laces, at the Island of Burano, near Venice. "This island, in the 16th and 17th centuries, was one of the principal seats of the celebrated lace manufacture of the Venetian provinces. The formation of the school recently established there, and the revival of the art of lace-making in Burano, arose out of the great distress which, in 1872, overtook its inhabitants. The extraordinary severity of the winter of that year rendered it impossible for the poor fishermen, who form the population of the island, to follow their calling. So great was the distress at that time, that the fishermen and their families were reduced to a state bordering on starvation, and for their relief contributions were made by all classes in Italy, including the Pope and the King. This charitable movement resulted in the collection of a fund of money, which sufficed to relieve the immediate distress and leave a surplus applicable to the establishment of a local industry, which seems to be not unlikely to permanently increase the resources of the Burano population.

"Unfortunately, the industry at first fixed upon, namely, that of the making of fishermen's nets, gave no practical result, the fishermen being too poor to purchase the nets. It was then that a suggestion was made by Signor Fambris that an effort should be made to revive the ancient industry of lace-making. Princess Chigi-Giovanelli and Countess Andriana Marcello were asked to interest themselves in and to patronise a school for this purpose. To this application those ladies yielded a ready assent, and at a later period Queen Marguerite graciously consented to become (as her Majesty still is), the president of the institution.

"When Countess Marcello (who from that time has been the life and soul of the undertaking) began to occupy herself with the foundation of the school, she found an old woman in Burano, Cencia Scarpanile, who preserved the traditions of the art of lace-making, and continued, despite her seventy years and upwards, to make "Burano Point." As she, however, did not understand the method of teaching, the assistance was secured of Madame Anne Bellorio d'Este, a very skilful and intelligent woman, for some time mistress of the girls' school at Burano, who in her leisure hours took lessons in lace-making of Cencia Scarpanile, and imparted her knowledge to eight pupils, who, in consideration of a small payment, were induced to learn to make lace.

"As the number of scholars increased, Madame Bellorio occupied herself exclusively in teaching lace-making, which she has continued to do with surprising results. Under Madame Bellorio's tuition, the school, which in 1872 consisted of the eight pupils (who received a daily payment to induce them to attend), now numbers 320 workers, paid, not by the day, but according to the work each performs. In this way they are equitably dealt with, their gains depending on their individual skill and industry.

"In Burano everything is extremely cheap, and a humble abode capable of accommodating a small family may be had for from 600 to 1,000 Italian lire. It is not a rare occurrence to find a young girl saving her earnings in the lace school, in order to purchase her little dwelling, that she may take it as a dower to her husband. Nearly all the young men of Burano seek their wives from among the lacewomen, and the parish priest reported last year facts which showed conclusively that the moral condition of the island, consequent on the establishment of the lace school, has improved in a very striking degree.

"The lace made in this school is no longer exclusively confined, as in the origin it was, to Burano Point, but laces of almost any design or model are now undertaken.

"In order the better to carry out the character of the different laces, the more apt and intelligent of those pupils whose task it is to trace out in thread the design to be worked, have the advantage of being educated by means of drawing lessons from professional artists.

"The 320 workwomen now employed are divided into seven sections, in order that each may continue in the same sort of work, and as far as possible, in the same class of lace. By this method each one becomes thoroughly proficient in her own special department, executes it with greater facility, earns consequently more, and the school on its part gets the work done better and cheaper (although of course cheapness must always be very relative)."

XXVII. Besides specimens of lace now made at Burano, on the table before us, I can show you two slides of the lace. The first (Fig. 6) is a needle-point lace, "à brides," with a marked *cordonnet*. It is rather in the style of so-called Argentan designs. The second (Fig. 7) is more in the style

Fig. 6.

Needle-point lace. Burano. 19th century (1879).

Fig. 7.

Needle-point lace. Burano. 19th century (1879).

of 17th century Venetian needle-point lace, with a ground of hexagonal "brides" with "picots."

We have now to consider machine-made lace. And in approaching this section of my lecture, I must tell you beforehand that it is difficult to attempt to give a short description of the process. Of course, if we had had to discuss the mechanism of man, why and how his mechanism permits the manufacture of lace, in the same way that we may discuss the lace-making machine, the human machine would be the more wonderful of the two. Still, whereas I have devoted two lectures to processes of making lace by hand, and now propose merely to give a portion of a lecture to lace-making by machinery, you will not suppose that this determines the relative importance between the two branches of lace-making by hand and by machinery.

Mr. William Felkin has written a considerable work upon the lace machine. He shows that it is very much from the art of knitting that we trace the origin of the machine for making lace. Knitted caps and hose date in England from the end of the 15th century at least; as various Acts of Parliament testify. Knitted stockings, however, possibly from the difficulty of forming the heels and feet, seem to have been later, for Henry VIII. is said to have had, for ordinary wear, cloth stockings, "except there came from Spain by chance a pair of silk stockings." Even as late as 1610, "so unfashionable were young gentlemen commoners," that George Radcliffe, writing from University College, Oxford, to his mother, asks for a green baize table-cloth, "of which, if too little for my table, I will make a pair of warm stockings." But some 27 years previously to this, the town of Sheffield can claim the credit of having given from its trust funds 13s. 3d. to "William Lee, a poore scholler of Sheffield, towards the settynge him to the University of Chambridge and buyinge him bookes and furniture." This William Lee, who became a clergyman, was for some reasons expelled from his college (St. John's), where he held a fellowship. He appears to have married an innkeeper's daughter, and after the loss of his fellowship soon fell into extreme poverty. In his distress to find a source of income, his inventive faculties were called into play. The only support for his wife and child appears to have been derived from the sale of hand-knitted stockings. Sitting constantly with his wife, the scholar often fixed his attention on her dexterous management of the needles. In course of time he invented a mechanical contrivance, by which stockings might be more quickly knitted than by the hands. This is generally accepted as the first stocking-loom. The news of this invention, which was at once recognised as a formidable rival to hand-work, soon spread, but the antipathy to it prevented its becoming successful in England. Queen Elizabeth regarded with contempt a man's invention of a mechanical weaver of stockings, and the Rev. William Lee's petition to her Majesty for Royal patronage passed unnoticed. From James I., Lee gained as little encouragement. He accordingly went to France. Henry IV. and his minister Sully warmly espoused his cause, and matters went prosperously with Lee until his death. It might from this be supposed that France remained in solitary possession of this valuable invention, but Mr. Felkin tells us that Mr. James Lee, son of Rev. William Lee, soon after his father's death, determined to transplant the manufacture of knitted stockings by machines to England. He accordingly brought frames and experienced workmen to London, and started operations in Old-street-square. Upon this becoming known, a spirit of imitation seized different people. Stocking-knitting frames were set up in Nottingham. Venice, the old home of artistic lace-making, was almost foremost in striving to establish stocking-knitting factories, but her attempts in this direction, through lack of skilled workmen, who should replace plant as it was worn out, soon collapsed. England, however, rapidly developed the number of her stocking looms, and between 1670 and 1695, upwards of 400 such machines were exported to France, Flanders, Spain, Italy, and Sicily. The English Legislature about this time placed its veto upon such exportation. The manufacture in this country continued in great force. Charters were granted incorporating companies for the working of stocking machines, and Parliament was called upon to consider petitions from the various manufacturing centres. In 1758, Mr. Jedediah Strutt introduced a method of ribbing stockings as they were made, and the machine for so doing was called the Derby rib machine. Other modifications of the stocking machine followed. It was about this time that taste for lace ruled that meshed grounds lightly sprinkled with small ornaments should be the most fashionable laces. Hence fine meshed fabrics like net and tulle seem to have arisen. Manufacturers in London and Nottingham applied themselves to make lace net upon stocking frames, about 1770, and so far as plain nets were concerned, they were successful in producing looped net fabrics of perfect regularity. Early in the present century, Mr. Heathcoat, of Nottingham, invented a machine for making bobbin net. After him came Mr. John Leaver, whose lace-making machines and modifications and improvements of them, to which have been applied the apparatus of the celebrated Jacquard loom, are in use at the present time.

XXX. Broadly speaking, lace-making by machinery is more nearly like the pillow-lace making process than that of needle-point. The machine contrives to twist any desired threads around one another. In pillow-lace making, besides twisting, we have plaiting. This plaiting has not been reproduced by the majority of lace machines. Quite recently, however, a French machine, called the "Dentellière" has been invented to do plaiting. Time will not allow me to refer in detail to the "Dentellière," of which a description has been published in a journal, entitled *La Nature*, dated 3rd March, 1881. Whilst, as we shall see, the ordinary lace-making machine belongs to the family of weaving machines, the "Dentellière" more nearly resembles the pillow of a lace worker, with the threads arranged over the pillow. In general appearance it looks something like a large semi-circular framework of iron, with thousands of threads from the outer semi-circle converging to the centre, representing the table or pillow. Over this central table is the apparatus which holds the end threads

side by side, and which regulates the plaiting of them. The cost of producing lace in this manner is said to be greater than by hand.

XXXI. In respect now of the lace machine which is in common use, I would ask you to reflect, that the mechanism to obtain and regulate the motions of each thread is intricate, and represents the sum total of much scientific thought, and its application to guide practice over a long course of years. Of the number of threads worked by a Leaver's machine, like that described in the *Journal of the Society of Arts* (18th and 25th Sept., 1874), it may be sufficient to say that there may be some 8,880. Of course the pattern to be worked into lace governs the number of threads. To produce the pattern shown in the *Journal* above-mentioned, 48 bobbin or shuttle threads, and 100 beam or warp threads were employed for each piece of lace. Sixty pieces of lace were simultaneously wrought, and thus sixty times 148 threads were brought into operation. This gives a total of 8,880 threads. Now, each of these 8,880 threads had its own particular duty to perform, and I hope to be able to convey to you some slight notion of these duties.

XXXII. The threads in a Leaver's lace machine then, may be divided, as they are in the loom, into two sets, the one which we may call the warp or beam

Fig. 8.

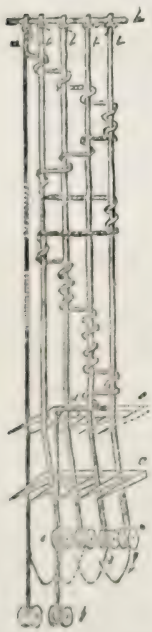


Diagram showing action of a slack weft thread in connection with taut warp threads.

Fig. 9.

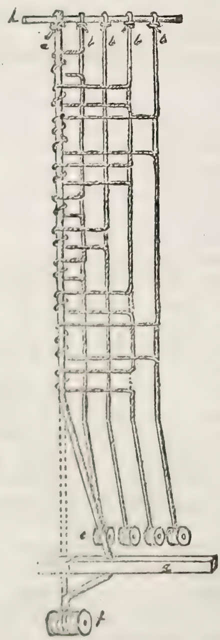


Diagram showing action of taut weft thread in connection with slack warp threads.

threads, and the other the weft or shuttle threads. The ends of both sets of threads are fixed on a cylinder or lace beam, which corresponds in its use with the first row of pins on the pillow, in pillow-lace making. The supply of the threads, warp and weft, is held by reels or bobbins. The reels of the warp threads are different from those of the weft threads. The warp thread reels are arranged in trays or frames beneath the stage, above which, and between it and the cylinder, the twisting of the weft with the warp threads takes place. The supplies of the weft threads are contained in flattened reels or bobbins, which are of a shape as to be conveniently passed between the stretched warp threads. Each bobbin for the weft thread can contain about 120 yards of thread. By most ingenious mechanism, varying degrees of tension can be imparted to the warp or weft threads. The bobbins of the weft threads, as they

Fig. 10.

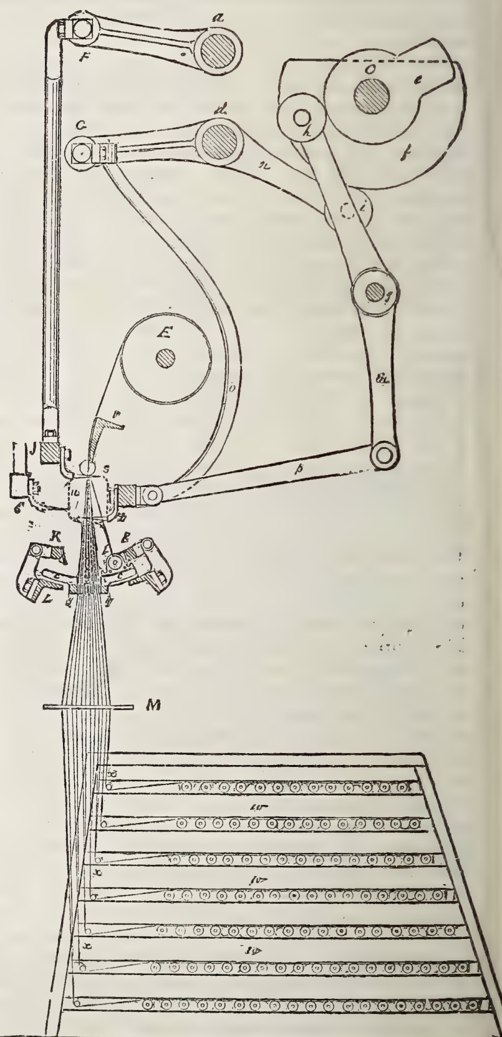
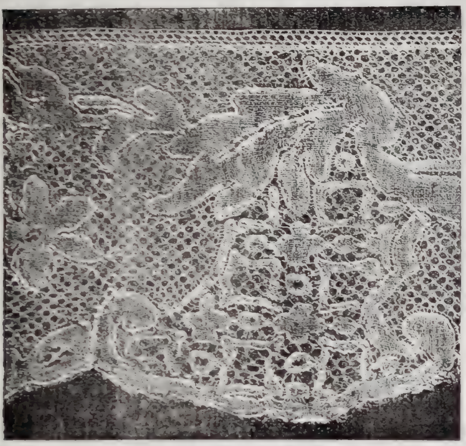


Diagram of principal details in a lace-making machine.

pass like pendulums between the warp threads, are made to oscillate, and through this oscillation the threads twist themselves, or become twisted with the warp threads. As the twistings take place, combs passing through both warp and weft threads

compress the twistings. Thus the ordinary machine-made lace may generally be detected by its compressed twisted threads. In it will not be seen any plaiting, such as we find in pillow-lace, or lace made by the "Dentellière" machine. We cannot, moreover, trace in machine lace any simulacrum of button-hole-stitch work, as we have it in needle-point work.

FIG. 11.



Pillow-made lace. Mechlin. Early 18th century.

XXXIII. The diagrams (Figs. 8, 9, p. 806) are intended to show the effects obtained by varying the tensions of weft and warp threads. For instance, if the weft threads, *b b b b*, in Fig. 8, be taut, and the warp thread slack, the warp thread will be twisted upon the weft threads. But if the warp thread (*b b b b*) be taut, and the weft thread (*a* in Fig. 9) slack, then the weft threads will be twisted on to the warp

FIG. 12.

Machine-made imitation of Mechlin pillow lace.

thread. At the same time we should remember that the twisting in both these cases arises from a conjunction of the movements of the two sets of threads in this matter, namely, the movement from side to side of the beam or warp threads, and the swinging or pendulum-like oscillations of the bobbin or weft threads between the warp threads.

FIG. 13.

Pillow-made lace. Mechlin. 18th century.

XXXIV. The diagram (Fig. 10, p. 806) represents a section of part of a lace machine, showing E, the

FIG. 14.

Machine-made imitation of Mechlin pillow lace.

cylinder or lace beam, upon which the ends of both warp and weft threads are fixed at starting. Beneath is *w w w*, a series of trays or beams, one above the other, containing the reels of the supplies of warp threads; *r r* represents the slide bars, for the passage of the bobbin *b*, with its thread, from *k* to *k*, the landing bars one on each side of the rank of warp threads, *s t*, are the combs which take it in turns to press together the twistings as they are made. The combs are so regulated that they come away clear from the threads as soon as they have pressed them together, and fall into positions ready to perform their pressing operations again. This by no means exhausts the story of all that the lace machine does. The contrivances for giving each thread a particular tension and movement, at a certain time, are most subtle. They are closely related to the Jacquard system of pierced cards. The machine lace pattern-drafter has to know more of this mathematical calculation than of drawing lines and curves. His work consists, principally, of calculating how many holes shall be punched in a card, and of settling where each hole is to be punched. Each hole regulates the movement of a thread

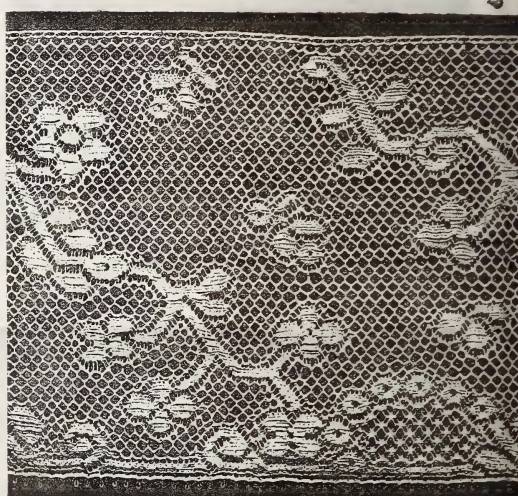
XXXV. We may now look at a series of specimens of machine-made laces. The first specimen (Fig. 11) is that of a Flemish pillow-lace design of the early 18th century. In it you will notice the variegated appearance of the meshes of the ground. A thread, you see, outlines the pattern, which has a fine linen appearance. Now the manufacturer (see Fig. 12) has merely attempted to reproduce the pattern. His meshes are regular. No outlining thread marks the pattern, which, instead of being filmy, like linen or cambric, is ribbed. This specimen, recently made at Calais with a Leaver machine, which is worked upon the principles I have above mentioned. The cost of this machine lace is 1s. 2d. a yard, and the value of the original is £1 5s. per yard. The next specimen (Fig. 13, p. 807) is that of a piece of Mechlin pillow lace of the late 18th century. In this you will again observe the comparatively slack manner in which the threads in the ornament are twisted and intercrossed. Here is the mechanical counterfeit of this piece (Fig. 14). The ground is similar to wire netting, while the threads to imitate these slack twistings of the original are rigid and much more regular. This, too, was made at Calais. The value per yard of the hand-made lace is £1 10s., whilst that of the machine is 2s. 9d.

XXXVI. I have now a better example of machine imitation of Mechlin lace. Here is the original lace. The appearance of the thread, forming blossoms, which seem to be a kind of sunflower, a series of petals around a dark central disc, is similar in their looseness to those in the preceding specimen. Now, in the imitation produced by the machine, we have an ingenious twisting given to the threads of the ground, whereby, in lieu of the simple twisted ground-net of the previous example of machine, we have two sides of each mesh thickened to represent the two plaited sides of a hand-made Mechlin mesh. In obtaining this effect, however, the machine has to forego a looseness in twisting the other four sides of each mesh, which, consequently, have a tighter and harder appearance than that given to the corresponding sides of meshes, shown in the original pillow Mechlin and in the Calais imitation. This, however, is a very small matter, compared with the fidelity in general appearance, which the Nottingham imitation before us possesses. This invention is considered to be the best of its kind. The cost of the hand-made lace, of which this is an imitation, is £1 10s. a yard. It was made last year at Louvain, and is a copy of a pattern introduced towards the end of the 18th century. The machine imitation wrought this year at Nottingham by a Leaver's machine costs 1s. 3d. a yard. The whole of the work is done by the machine, including, of course, the outlining thread. Machine lace, made with such outlining threads, has to be trimmed, so that these outlining threads which run from pattern to pattern, may be disunited, and left only around the required portion of the pattern.

XXVII. Here, however, we have an imitation lace, the *cordonnets* in which is worked in by hand. This specimen was made this year at Lyons. Hitherto we have seen machine-made imitations of the Mechlin class of pillow lace, *i.e.*, laces with a thread outline to the pattern. Now, however, we will look at imitations of Valenciennes lace. First of all, we may remind ourselves of the appearance of hand-made Valenciennes.

XXXVIII. Here, now, in Fig. 15, is a good

FIG. 15.



Machine-made imitation of Valenciennes pillow lace.

quality of machine-made Valenciennes. It is made at Calais, by machines similar to those used at Nottingham. Another specimen is more elaborate in design, and woven with finer thread. It is considered to be as good as the machine can make.

XXXIX. The last illustration I have to show is a copy made at Nottingham last year of a specimen of that fine filmy needle-point lace made in the 17th century at Venice, and still made with great skill at Burano. This (Fig. 16, p. 809) is a specimen of the original lace, valued at about £5 5s. a yard. You will observe the flat and even appearance in the close portions of the pattern, the slight outline of thread, as well as the delicate tracery work, reminding one almost of a distant view of some fine Gothic rose window.

XL. Here we have the machine imitation (Fig. 17). In spite of the ribbed appearance of the close portions, the sharp, clear, outlining thread, and the comparative wiry tautness of the ground, and of the little traceries, it is a wonderful piece of imitation.

Fig. 16.

Venetian needle-point lace, "à réseau." 17th century.

XLI. How much further man's ingenuity may compel mechanism to produce works, delusive counterfeits of handicraft, is a question not to be easily answered, if answered at all. For anyone desiring to follow the history of the art of lace-

Fig. 17.

Machine-made imitation of Venetian needle-point lace, "à réseau."

making in its literary aspect, there is plenty of ground to be travelled over. But as I said in an earlier lecture, I do not think that this way of proceeding is as instructive as it is entertaining; and I doubt very much if any one adopting it would come

> To know the age and pedigrees,
> Of points of Flanders and Venise.

XLII. In the times of the Provence romance writers, French ladies as they worked sang "Chansons à toile." Italian poets have sung the praises of the needle, just as Taylor, our Elizabethan water poet, has lauded the "Needle's excellency." Some verses composed by Jacob Van Eyck, in the 17th century, upon the art of lace-making, and a French epic, entitled, the "Revolte des Passements," appeared about the same time. Pope, Evelyn, Swift, Congreve, and many other writers of the 18th century comment on passing fashions, and refer to laces then in vogue.

XLIII. One of the latest of English poets, who seems to have perceived that patience, perseverance, gentleness, should predominate in the character of a lacemaker, is Mr. Lewis Carroll, who has immortally associated a beaver with the art. A "beaver that paced on the deck, or would set making lace in the bow," was a member of that notable band of personages who went out hunting a snark. But when, as the poet relates,

> The Boots and the Broker were sharpening a spade,
> Each working the grindstone in turn;
> The Beaver went on making lace and displayed
> No interest in the concern.

XLIV. The Barrister, another of the hunting party,

> Tried to appeal to its pride,
> And vainly proceeded to cite—
> A number of cases, in which making laces,
> Had been proved an infringement of right;
> But the Barrister, wearied of proving in vain
> That the Beaver's lace-making was wrong—

soon fell asleep, and leaving him in that condition, I will conclude without making further quotations from this strange poem, which may not enlighten us much upon the art of lace-making. As it mellows with time, perhaps it may fall into its place as a stepping-stone in the literary history of lace-making.

XLV. It has been a privilege and pleasure to me to have been permitted to deliver this course of lectures upon the art of lace-making. In offering you my thanks for your forbearance with my shortcomings, as well as for the kind and appreciative attention you have evinced, I can but say that any dreariness which has attended my own personal efforts has, I hope, been relieved to some extent by the excellent illustrations furnished for our instruction and diversion by the authorities of the South Kensington Museum, Captain Abney, F.R.S., Sir William Drake, Mrs. Robert Goff, Mrs. Alfred Morrison, Mrs. Enthoven, Messrs. Hayward, and Messrs. Howell and James.

MISCELLANEOUS.

THE SOCIETY OF ARTS' PATENT BILL.*

By Sir Frederick J. Bramwell, F.R.S.

The Section will have observed that, in the report of the committee,† which has just been read, no opinion is

* A paper read before Section G. (Mechanical Science) of the British Association, at the York Meeting, September, 1881.

† Report of a Committee of the British Association on Patent

expressed in reference to the Society of Arts' Patent Bill. The reason for this (I am in a position, as secretary of the committee, to say) was twofold—one, that the Bill came before the committee only a very short time before the meeting of the Association; the other, that the majority of the members of the committee then present had actually been engaged in the preparation of the Bill itself. The committee, you will see, asks to be re-appointed; and I am sure I am expressing their feeling when I say that they will be glad to have the benefit of a free and open discussion upon the Society of Arts Bill, in order that they may profit thereby in determining on the conclusion that they should come to in making their next report to the British Association. The Society of Arts has for many years past taken a warm interest in the question of the Patent-law. It assisted materially in the passage of the Act under which patents are now granted—that of 1852. It has, from time to time, had meetings and discussions upon the subject; and seven years ago, moved thereto by the observations by certain journals believed to be prompted by persons of position, the Society thought it desirable to have the matter thoroughly well gone into. I had the honour of reading a paper on the subject in the month of November of 1874, which resulted in a protracted discussion, and, I am glad to say, in an almost unanimous expression of opinion—an opinion fortified by that of nearly every journal that noticed the discussion, and the journals that did so were very numerous—that a Patent-law was an undoubted necessity.

The various Bills introduced by the late Lord Chancellor and the late Attorney-General, and the promise made by the President of the Board of Trade of a Bill next year, are proofs of the concurrence of the Governments, both past and present, in this view. In the remarks I am about to make on the Society of Arts' Bill, I therefore intend to take it as generally conceded that there must be a Patent-law, and that the question before us is confined to the consideration of what should be the nature of that Patent-law; and I doubt not that our Chairman, in inviting the meeting to discuss this paper, will ask members to be good enough to do so in the spirit in which it is written—namely, to consider whether the Bill of the Society of Arts is one which should meet with approval or otherwise, and not to discuss the question as to whether there should, or should not be, a Patent-law at all.

At the beginning of its last Session, the Society of Arts appointed a committee, consisting of the chairman of the Society's Council (myself), Professor Abel, Mr. Alfred Carpmael, Sir Henry Cole, Captain Douglas Galton, Mr. W. H. Perkin, Dr. Siemens, and Mr. H. Trueman Wood. The committee commenced their work by drawing up a series of questions as to the mode in which a Patent-law should be framed, in regard to certain points specially enumerated; and, having done so, they asked their Secretary, Mr. H. Trueman Wood, who is helping here to-day as one of the Secretaries of Section G, to obtain and tabulate, for the information of the committee, a statement of the manner in which those various points were dealt with by the Patent-laws of other nations. Furnished with this information, the committee considered the questions which had been drawn up, and came to conclusions upon them. They were thus enabled to prepare "instructions" to guide a Parliamentary draughtsman in the preparation of a Bill. It may be as well to state at once that, in framing the Bill, the committee did not allow themselves to be guided by considerations of expediency, that is to say, by considerations of what it is likely would be embodied in any Bill prepared by Government, but they thought it right to draw up, to the best of their ability, such a Bill as they believed would be to the advantage of the community at large, and such a Bill as they themselves would pass, if, happily for manufacturers and commerce, the Legislature would, on this point, delegate its power to the Society of Arts. Some of those present may think that the committee might well have exercised their functions by making suggestions of alteration in this or that clause of the existing Act; but, having regard to the many abortive attempts of this sort which have been made, and having regard also to the fact that when it is essayed to vary and patch up an existing Act, it is extremely probable some of these variations will be found inconsistent with that which remains—the committee determined to prepare a thoroughly complete Bill. The Bill having been submitted to the Council of the Society of Arts, has been provisionally approved by them; but they determined that, before the next Session of Parliament, it would be desirable that their Bill should be thoroughly canvassed. They therefore gave notice of their intention to summon a meeting of the Society of Arts after the vacation, for the purpose of considering the Bill, and discussing it. Guided by the opinions expressed at this discussion, the Council will either retain the Bill in its present form, or will make such alterations in as may be deemed expedient, and will then finally issue it as the Bill which the Council of the Society of Arts would desire to see passed in its entirety. I am quite sure that I am acting consistently with the wishes of my colleagues on the Council, in bringing the matter before the Mechanical Section of the British Association, in order that they may be benefited by the discussion which will ensue here, and the opinions which will be expressed.

I do not think it is too much to say, that previous Acts of Parliament have been framed with the view that on one side there was the public, and on the other side the patentee; that only so much ought to be given to the patentee as would lead him to communicate, in the first instance, his invention to the public, but that every attempt should be made in subsequent proceedings to oust him from his privileges, in order that the invention might be thrown open on the earliest possible day. In the paper I read before the Society of Arts, to which I have already alluded, I went fully into this view of the subject, and adduced arguments to prove it was in the interest of the community, as being necessary for the development of an invention, that it should be not public, but individual property. It would occupy too much time to repeat the whole of these arguments, but among them were the following:—That those who had capital embarked in plant, did not desire to see that plant made useless by the mode of manufacture being changed by new inventions, and that, unless they were tempted by the prospect of protection for a certain number of years, they would not enter upon a novel course which would result in thus depreciating the capital invested in their manufacture; that most patented matters, although sufficiently specified, required practical development, a development which can only be secured by the invention passing through an experimental stage. Under the protection of a patent, the manufacturer is willing to incur the necessary expense for this, and also the risk of his plant being eventually thrown out of use; but, without a patent, no manufacturer would run these risks, because he would be aware that when he had succeeded in overcoming the practical difficulties, his competitors in trade could then go to work upon the invention, without themselves having these practical difficulties to overcome; and thus the man who first took up the invention would be the one who would obviously make the least money by it. For these and other like reasons, which I will not now repeat, I showed that the absence of a patent would be really a bar to the adoption of the invention. I was much struck by a statement of a member of the Society of Arts, Mr. Arthur Barff, which

Legislation. This report enumerates the measures for the reform of the Patent-laws submitted to Parliament during the past session, and reprints without comment the abstract of the Society's Bill, which was published in the *Journal* for 5th August last.

he made in a communication to the *Journal*, in answer to an inquiry why liquid fuel was not employed for steam-engine purposes, and especially for steam vessels. He said, that so many attempts in this direction had been made and published, that no valid patent could be obtained, and that thus, it being nobody's interest to push the invention, the invention was not pushed, and was not brought into use. I am quite sure that Mr. Barff was perfectly right in his view of the case. I would repeat on this subject that which I have often quoted, because it is so very true and so very apt, an expression made use of by our Chairman of to-day —Dr. Siemens—namely, that for the interest of the community, if an invention were found lying, like some orphan child, in the gutter, some one should be selected, as its foster father, to take up that invention.

This need of a patentee in the development of an invention was the first point the committee kept before them. The second point the committee had in view, was that, so far as possible, the connection between lawyers and patents should be severed. There can, I think, be little doubt that whether in regard to the original granting of patents, or in regard to their amendment, or in regard to the trial of patent actions, lawyers are the persons least adapted to perform these functions properly. No one entertains a more sincere respect than I do for the Bench and the Bar of England, and I wish, in the interests of that respect, to see them discharged of functions which most certainly they ought never to have had thrust upon them.

Fortunately, having regard to the magnitude of the transactions involved in patent matters, there is but very little patent litigation. In the year 1874, it was ascertained for me that there were, upon an average, only nine patent actions which went so far as to be heard by a Court of First Instance in each year; and I have no reason to suppose that that number has materially increased, if, indeed, it has increased at all. But, with respect to the few actions that are tried, a very considerable part of the expense arises from the elaborate models which are needed to instruct counsel upon the subject, who themselves have to inform the Court, and also the jury where there is one. And further, commonly, notwithstanding all the expense that is gone to, and the pains that are taken, the litigants have the chagrin of seeing that they have not been successful in making themselves understood either by the Court or the jury, or, it may be, not even by their own counsel.

Having thus stated to you the history of the Society of Arts' Bill, and the main principles upon which it is founded, I will now briefly touch upon one or two of its leading features, showing how it has been framed with the view of carrying these principles into effect, referring the Section to the printed memorandum which has been distributed amongst them for further information on the subject. The Patent Bill has already appeared *in extenso* in the Society of Arts' *Journal* of August 5, 1881, and a few copies of it in the Parliamentary form are here, for the use of those who wish to ascertain the exact wording of any particular section.

It will be seen by the memorandum, the first proposition is, that there should be appointed, in lieu of the present Commissioners, who are all legal officials, a body of three Commissioners, one of whom should be well acquainted with Engineering, one with Chemistry, and one with Law. Power is given to the Commissioners, with the approval of the Treasury, to appoint the needful staff. It is intended that these Commissioners should be the persons to grant patents, after a slight examination by examiners, not as to novelty, not as to utility, not as to sufficiency of invention, but simply to ensure that the necessary forms are complied with, and that a sufficient description is given.

The Commissioners, also, are those who would hear Oppositions, which it is proposed to confine to persons who allege that the invention has been fraudulently obtained from them. They are also those who would consider as to Amendments, and as to Prolongations—and it is intended that both Amendments and Prolongations should be made more easy than they are at present. And, finally, it is the Commissioners who would hear patent causes. This remitting to the Commissioners the trial of patent causes is, probably, the most thorough change made by the Bill, but the committee consider they are not without a precedent in the matter. It is now many years ago since the Railway Commissioners were appointed for the express purpose of determining questions between railway and canal companies and the public, and it is quite certain, that if it were found expedient to appoint a special body for the purpose of determining questions which involve no details of machinery, which demand no knowledge of chemistry, but which are simply questions of contract, or of the application of rates and charges of various amounts to various circumstances, still more is it needed that there should be a special tribunal for the trial of patent causes, involving, as they commonly do, matters with which no existing tribunal is competent to deal.

Among the other provisions it will be found, on examining the Bill, that the procedure has been modified, with the object of helping the patentee to obtain his patent more easily than at present, and more cheaply, and also with the object of rendering the patent more secure when he has once obtained it. That an attempt has been made to settle the vexed question of subject matter, by substituting a fresh definition in place of the practically obsolete one contained in the Statute of Monopolies—"A New Manufacture within this Realm."

With respect to pleas in patent actions at the present time, the defendant, even if he has undoubtedly pirated and used, without the patentee's consent a valuable invention given to the public by the patentee, is enabled successfully to resist an action brought against him, if he can prove that some of the matter comprised within that patent, matter which he has not infringed, is not new, although the particular matter which he has infringed is new. He is also enabled to succeed in his defence, if he can show that these other matters which he has not infringed are, inadequately specified. He is also enabled to succeed in his defence, if he can show from a consideration of the Provisional Specification, that the matters claimed in the final specification were not those for which, strictly and legally speaking, the patent was granted. It is true that, if the defendant succeeds on any of these points, the patentee can commonly cure the defect in his specification by a disclaimer; yet even that is not secured to the patentee as matter of right, but as a matter of grace and favour, and is, if granted, too commonly coupled with conditions. And with regard to this question of want of novelty, it is sufficient for the defendant's purposes if a single publication—say in the British Museum—of 50 or 100 years old, not looked at once in ten years probably, and utterly unknown to those engaged in the manufacture to which the patent relates, can be raked up, and can be shown to contain, it may be, not the invention as described in the specification, but something which may be said to come within the general terms of the claim. The committee who framed the Society of Arts' Bill, as you will have gathered from what has already been said, are of opinion that it is contrary to the interests of the public that a patentee should be deprived of his invention by what, after all, are technicalities. Further, it is a very common thing for a patentee to obtain Provisional Protection, and having done so, either through being too much occupied with other matters, or through being incompetent to develop his own idea, to abandon the further proceeding with the patent, and to allow his Provisional Protection to lapse, and thereupon the Provisional Specification is made public. I believe I am right in saying that something like 30 to 40 per

cent. of all the inventions for which Provisional Protection is obtained, do not go beyond that stage, The result is, that there is made public, legally speaking, a mass of crude and undigested matter. always useless to the manufacturer, but commonly destructive of the novelty of a patent which might come afterwards, and be fully worked out by an inventor. I may mention, as illustrative of this, a circumstance which occurred to myself. Some years ago, I invented a mode of making chain cables without any welds in the links, but before I applied for Provisional Protection, I caused a search to be made at the Patent-office, and there discovered a Provisional Specification, showing that the primary idea I had, had been conceived by the person who lodged that Provisional Specification, but who had not proceeded with his patent. Therefore, if I had gone on, I could not have maintained a patent for the original invention, but simply for the details. I did not deem it worth my while to proceed under these circumstances, and it is certainly not worth the while of any manufacture of chain cables to carry out the idea which was in my mind, and in that Provisional Specification. It is on such grounds as these, that the committee who have prepared the Patent Bill of the Society of Arts, propose the Provisional Specification should be a merely temporary document, and that it should never be made public so that whether a patent be granted, or whether the Provisional Protection be suffered to lapse, the document should be destroyed. Similarly, it appeared to the committee that it was inexpedient a patent should be rendered invalid by any dormant publication, such as a book in the British Museum, and therefore they proposed, that unless an invention can be proved to have been in use within thirty years, no mere publication, unaccompanied by use, should be considered an anticipation of a patent. With respect to the term of a patent, it will be seen that the committee suggest the American term of 17 years, coupled with the power of Prolongation for a further 11 years. The term of 17 years has been taken, coupled with this power, in preference to the term of 21 years proposed in the Government Bill of 1879, unaccompanied by Prolongation, as the committee deemed that 17 years, if the patent were successful, would afford the patentee sufficient remuneration, and also, that having once established a body competent to deal with patent matters, there would no longer remain the difficulty of obtaining satisfactory decisions in cases of Prolongation. The scale of fees proposed, in order to obtain a patent, is that of the Government Bill of 1879, and, as regards the subsequent payments, is practically the same as was proposed in that Bill.

In this, the most recent Government Bill, provisions were made for the cessation of the patent if the invention were not put to work within a given time, and, in addition, provisions were made that compulsory licenses should be granted by the patentee. The committee of the British Association which considered the Government Bill of 1879, strongly urged the undesirability of the first of these provisions, and pointed out that where a patentee was bound to grant a license, there was no reason why he should be deprived of his patent, if he himself failed to put it to work, and they gave instances in which it would be extremely difficult for the patentee to obtain a trial of his invention, and they urged, that if a proper provision were made for obligatory licences, no duty should be imposed on the patentee as regarded putting his invention to work within a given time. One of the greatest difficulties which the committee of the Society of Arts encountered, was to determine whether or not obligatory licenses should form a part of the Bill. The subject is a complex one, and not so readily disposed of as perhaps those who have not studied it may imagine. I do not propose to enter into it here, but I shall be very happy to answer any questions on the point, or, indeed, on any other point, that may be put in the discussion. It will at present suffice if I say, the committee, at length, unanimously came to the conclusion it was, on the whole, expedient that obligatory licenses, guarded, however, in the way provided for in the Bill, should form one of the provisions of that Bill. Bearing in mind, as I have stated, that you have before you a memorandum showing the principal alterations, and that those who desire it can be furnished, as far as they will go, with the prints of the Bill, in order that they may refer to any particular clause on which they may desire to speak, I will not now occupy further the time of the meeting, as I think it will be better employed in hearing and in considering the opinions of those who are present.

The reading of Sir F. Bramwell's paper was followed by a discussion, in which Sir Antonio Brady, Mr. Jeremiah Head, Dr. Siemens, Mr. T. Hawkesley, Mr. H. Trueman Wood, and others took part:—

Sir Antonio Brady said—I should like, as representing the Inventors' Institute, to express my great gratification at the lucid and admirable discourse we have just listened to. Till now the Patent-law has been simply a license to go to law, and it has destroyed almost all the best patents that would have been granted if we had had a better law. The society which I represent have advocated cheap patents, and the only part of this Bill which I don't think will meet the views of the Inventors' Institute is that the fees are not reduced in proportion to what we think would be advisable. We think that it is a very unrighteous thing to tax any branch of industry exclusively—that taxes ought to be general. We think, further, that it is not right to tax individuals, and particularly to tax that brain power upon which mainly rest the advance and the prosperity of the industries of this great nation We have advocated a little further progress towards cheap patents than is in this Bill, and we think that the Patent-law in America should be more our model than it is now. We think that the country should not make any profit out of patents, other than what is necessary to keep up the Patent-office, and to provide for the interests of patentees by having a proper registration. We entirely endorse the views of Sir Frederick Bramwell as to the propriety of having a first examination of an elementary character as proposed in this Bill. We think that the Patent-office ought to be able to give all the assistance to inventors that is possible, for the great difficulty heretofore has been for a patentee, or intending patentee, to ascertain what has gone before. The registers have been so imperfect, and the difficulty of making examination is such, that we think the Patent-office ought to be organised in such a manner as to be able to give advice and assistance to inventors, to prevent them from running their heads against a post. It commonly happens now that the first comer gets the patent, whether the rightful owner or whether he is not. It is impossible to suppose that under the present system, if two people were to claim a patent on the same day, they would not get it, but under this Bill it would be impossible, and, therefore, we think it is a marvellous improvement upon the existing system. Moreover, there are very many elements in the Bill which are most admirable, and I am sure will commend it to the Inventors' Institute. When I get back to London I shall call a meeting of the members of that institute to take this Bill into consideration, and to see what support we can give to the Society of Arts, of which association most of us are members. I think the Society of Arts has done a very good thing for the industries of this country in bringing this Bill forward. It is a mistake to suppose that all patents are monopolies in the sense that some people have been trying to make them out to be ; they are a notice of an invention being made a part of the

property of the man who owns it. The law cannot give him an absolute power over it, because the Courts must decide many questions of patent rights afterwards; but I think it is a marvellous improvement that this Bill will give inventors generally, because it will be a very foolish thing for any person to contest a patent which has been granted under the provisions of this Bill; whereas now I am not wrong in saying that Sir Henry Bessemer, who has enriched the whole world by his inventions, has been put to enormous expense to defend himself against certain patents which were lying dormant, and has been obliged to compensate the owner of them rather than go to law in such cases. I think there are several other instances in which a small patent has cost £50,000 or £60,000 to defend it, which cannot be the case under such a Bill as this. Further, in the present day, the inventive genius of our people should be encouraged in every possible way. This is a small country. We cannot compete with larger countries, unless we utilise the brains of our people, and give them the assistance of the Patent-laws, which will encourage their inventive genius. You spoke, sir, just now, about Dr. Siemens, whom I am very glad to see in the room. I believe that I am right in saying that he could not get his patent in Germany, and we have had the advantage of his splendid genius and of his inventions, which we should not have possessed but for the Patent-law. I believe there are other instances—not, perhaps, of such an extent as this—and therefore I say that it is of the greatest possible moment to this commercial country to encourage the inventive genius of our people to the greatest possible extent; and I don't think there can be any objection in the mind of any sane man to extend a patent over a period of 17 years, as this Bill proposes. I should have preferred 20 years, as in recent Bills, but the Bill provides a power of extending the term under certain circumstances.

Mr. Jeremiah Head.—As one of the numerous class of patentees, I have asked for a moment or two to pay my modicum of thanks to Sir Frederick Bramwell for having brought this question before us. I can endorse all he says of the way that the law, as it now stands, seems to punish the patentee as much as ever it can. A man who has an invention has no way of gathering the information necessary, except by appealing to a patent agent, and although there is no reason to doubt that patent agents, as a rule, are honest, yet it is clear that their interest is rather in favour of encouraging a man to go on. The patentee goes on and spends, before he can complete his patent, something like £40, and in three years time he has to spend another £50. That is a very large sum of money, and yet it does not at all include what he has to spend in experiments. It is proved, by the large number of patents that are dropped at the various stages, that it would be better if a majority of them had never been taken out. They have been found either not to be new, or the inventors were not ready to incur lightly the great expense of bringing them to perfection, finding after two or three years that they had better drop them, after having lost a lot of money, of time, and of thought, and that, in fact, they were not the men to bring out the thing at all. No doubt, according to our present law, the Patent-office has got the man's fees, and does not seem to care, but that man is a disappointed man, and, therefore, I think that it is a disadvantage that he should have wasted his time and his money over an invention which had better have been brought out, if at all, by some one else. I did not quite gather from Sir Frederick Bramwell whether he proposed in this Bill that there should be any way or any body to whom an inventor, getting an idea, could write, on paying a small fee, and have his ideas submitted to some sort of preliminary test; whether on payment of such a fee he could be referred to this, that, or the other patent previously taken out, or some suggestion made to him, which, would, in many cases, discourage him from going on. I think that is very much wanted indeed, and it is only to be obtained now by appealing to patent agents, who do not always advise disinterestedly.

Mr. Barff—I just wish to ask one question, if there is any special reason for making the payment at the end of the fourth year so great as £10. We know that there are a great many patents that in four years cannot have paid themselves, and this tax of £10 seems rather high. The great advantage of an improved Patent-law would be that it would give men a greater interest in their work, as they would have some encouragement to study what they were doing every day, with a view to its improvement, and get a patent for the improvement. But I merely wish to ask whether this payment of £10 at the end of the fourth year is not higher than it need be.

Sir Frederick Bramwell—The payment at the end of the fourth year instead of £10 is £30.

Dr. Siemens, F.R.S.—If anything were needed to show the difficulty surrounding the framing of a good and just Patent-law, the observations that have fallen from the last two speakers would furnish incidental proof. Mr. Head, who is so well known for his mechanical talent, suggests that the obtaining of a patent should be made very difficult—that the patentee should not only prove that he had novelty, but that he had usefulness. I am afraid that, if that suggestion were adopted, many valuable patents would fall to the ground or be stillborn. It is the very essence of an invention that it cannot be worked in its first conception, because an invention is not a mere idea. An idea may strike the mind at one instant, but an invention is necessarily the result of labour—mental and physical—and of expenditure, and there is hardly an invention ever brought out that in its first stage would have stood such a test. I cannot agree with Mr. Head in supposing that all those inventions that have not taken immediate effect, and enriched the patentees, are so much loss to the country. On the contrary, although the inventor is to be felt for who has not reaped any benefit from his invention and for his labour, yet the public at large profits by it, because it may form the stepping-stone for somebody else to carry the idea to its practical point. The Patent-law must not be based upon the idea that all difficulties will be done away with, that all men are to be made happy, and that there is to be no legal contention of any sort. That would be a chimera such as could not reasonably be expected. If it is difficult to establish a title to landed property, surely it may be reasonably supposed that it is as difficult to establish a title to the product of the mind; and all we can do is to render the administration of that property as simple and as just all round as it possibly can be made, humanly speaking. The Patent-law worked out nominally by the Society of Arts, but in reality by my excellent friend, Sir Frederick Bramwell, is, I think, the best considered, and, perhaps, the most perfect attempt at a just and equitable law on the subject; and I, as one of the committee, can only hope that it will find favour in this Section in order that it may be strengthened by the weight of the British Association, and that the Legislature of the country may take a similar view. It is idle to discuss partial questions connected with such a law, as, for instance, that the fees to be paid by a patentee should be a great deal less. It is now proposed also to extend the operation of the patent over 21 years instead of 17. You may depend upon this that all these questions have been very carefully considered by the committee, and also tested by legal opinion, and that this Bill is the result of the careful and long meditations on the subject by Sir Frederick Bramwell, and of the discussions that took place in the committee, of

which he was the chairman. I may go further, and say that it is the result of previous discussions that have taken place, not only in this country, but abroad—in Vienna, where the Patent Congress met at the opening of the Universal Exhibition. Again, in Paris, where, at the time of the last Exhibition, a very long discussion took place, all these questions have been considered, and the best thing we can do is to accept it *en bloc*, and not attempt in the course of the slight discussion, such as we can afford to give to it, to alter any of its more important clauses.

Mr. Head, in explanation, said that he did not wish for additional difficulties to be placed in the way of inventors, but that inventors should be protected from the loss incurred by patenting old and worthless inventions.

Mr. H. Trueman Wood—I should like to be allowed to answer an objection, which has not been brought forward here, but which has appeared in one or two very influential journals, about the Society of Arts' Patent Bill. It has been said that the provision in it for examination would give the Commissioners the power of stopping invention, by refusing to allow an applicant to take out a patent. Now, as a matter of fact, the power given by this Bill is considerably less than that which is at present possessed by the law officers of the Crown; and I do not think it has been asserted that the present Patent-law, whatever else may be its defects, gives the power to stop invention. The very slight examination permitted under this Bill, is not an examination into merit or into novelty; it is merely a sufficient examination to enable the office to say that the matter in respect of which the application is made is really connected with Science, or Manufactures, or Commerce, and ought to be protected by a patent. My only reason for making this remark now is, that this objection has been urged very strongly, and I should be glad to have it put on record that no such power exists in the Bill. Indeed any person who reads it carefully will not be able to find any such power in it.

Mr. W. Hancock said that 20 years ago, at a meeting of the British Association at Manchester, he was on a committee that then sat on the Patent-laws. They had several very long discussions, especially as to whether there should be a preliminary examination. The broad conclusion arrived at was that it was desirable that there should be examinations as to novelty, but no examination as to utility. There was one thing that rather struck him, and that was as to the destruction of the provisional specification. If there was to be this destruction there should be the most stringent safeguards that the final specification does not trangress, or go beyond in any way the grounds of the invention at the time it was granted.

Sir Frederick Bramwell—Clearly it would be impossible to propose the destruction of the provisional specification, in those cases where the patent was granted, unless there were a competent examination to see that the completed specification did not go beyond that which was a fair development.

Mr. Hancock—That was the only thing that occurred to me that it would be dangerous to propose. I have been so much interested in patents, and have seen such terrible scandals done by the Patent-law, that I was strongly coming round to the conclusion that there appeared to be no possibility of arriving at such a conclusion as should fairly and justly reconcile the interests of the patentee and the interests of the public, which ought to be one.

A Member said this examination for novelty is not the dreadful thing it has been represented. In the interests of the public and the inventor a sort of optional examination for novelty would be exceedingly useful. Dr. Siemens has deprecated any suggestions as to any modification of this Bill which does not appear to be the view of the author of the paper. Dr. Siemens has told us we must accept it *en bloc;* that is hardly so. No doubt all inventors would say that it is an excellent Bill, and a great improvement on existing legislation, but it would be a still better Bill if the powers of the examiner were enlarged, so as to give a discretionary power with regard to novelty. If the examiner were enabled, with the knowledge he gained on an examination of patents, to report to the Commissioner whether a patent had been anticipated or not, and then the inventor were informed of the result of the examiner's investigation, I think we should have a marked and decided improvement.

Sir Frederick Bramwell, in reply, said—The last speaker was quite right in supposing that my object was not that the Bill should be either rejected or accepted *en bloc*, but that we should have the benefit of the opinions of the members present on its details. I am very glad that we have had that with respect to the examination as to novelty. It is one of the most difficult things to determine as to whether the examination should be made or should not be made, and the more difficult because of the danger of laying down any rule as to what should be considered to anticipate an untried invention. I think I am right in saying that, in Germany, Dr. Siemens was refused a patent for his regenerative furnace, on the ground that stones lining a cavity had been heated by a fire therein, and then, the fire being removed, the heat had been employed to cook whatever food was put within the cavity, and this process the examiner held to anticipate the regenerative furnace. I am aware this is an extreme case, and that it may be said we might reasonably hope to have more intelligent examinations with regard to novelty. But I very much fear that if the power of examination as to novelty were given, even if guarded by the provisions that the patentee shall have his patent subject to endorsement, the result would not be satisfactory. It is said not to be so in America; and after very great deliberation the Society of Arts Committee came to the conclusion that it was best to omit that examination. But I am sure this is just one of those points upon which the Council of the Society of Arts will only be too glad to have had an expression of opinion from gentlemen present. With respect to the suggestion about the provisional specification, the clause in the Bill—section 10, sub-section 3—sets forth that "On the grant or refusal of a patent, or of failure to prefer a request within the time allowed, the provisional specification shall be destroyed in the Patent-office, and until it is so destroyed its contents shall be kept secret." I quite agree that to prevent fraud, and to prevent the including in the final or complete specification and claims of a patent that which the patentee never invented, but which he had derived from somebody else after getting his provisional protection—to prevent that kind of fraud the provisional specification is most necessary, but when you have an examiner, as provided by this Bill, whose duty it would be to ascertain that the completed specification does not contain anything more than a fair development of that contained in the provisional specification, it does appear to me that, even if the patent is granted, it would be well that the provisional specification should be destroyed. It would be treated as a mere interim document for the information of the officer, whose duty it is to see that its contents have been complied with, and I cannot see that the continuance of it can do any good. But I do not attach so very much importance to its destruction in the case where an invention is proceeded with, and the whole matter is, by the complete specification, inevitably laid before the public; but I do attach great importance to that other part of the proposal, which is, that where an invention is not proceeded with, the

provisional specification should be destroyed as being, if made public, a bar to further improvement. But the question whether, in those cases where the patent is granted, the provisional specification should be destroyed, is one which will be well considered by the Society before the Council finally adopt the Bill. With respect to the question of fees, if they are made too low, I am afraid there might be such a mass of patents granted that they would be a nuisance; and I cannot help thinking that the opponents of a Patent-law altogether would chuckle at the notion of, say, a shilling fee or anything of that kind. I am aware, on the other hand, that it may be said it is a very hard thing that, because a man of great ability and ingenuity does not possess £10, and a man of less ability and ingenuity does, the former should be debarred from the protection which the latter can get. I am one of those who desire most earnestly that all those who have any good in them should be able to bring it out, and reap advantages for themselves, while giving the benefit of it to others, but there are a variety of things we should desire all people to have if it were possible, but, unhappily, it is one of the pains of poverty that they cannot have them, and, therefore, those who frame a Bill of this kind have to hold the balance between their desire of affording cheap patents and their fear that, if patents be made too cheap, they will be recklessly taken out, and will become so obnoxious as to lead to the abolition of patents altogether. Let me test this question of the necessity, in the interest of the maintenance of patents, of something more than nominal fees, by asking whether any one present would suggest that patents could survive if they were granted gratuitously. I am sure you feel that, if you issued gratuitous patents, they would be intolerable. What the fee should be it is most difficult to determine. Far am I from saying that the Society of Arts have adopted the right scale. I feel that I shall not be very wrong when I state that the committee were glad to base them on the scale in the Bill of 1879, which scale seemed to meet with very general approval, and they adopted it, with such modifications as were needed to vary the times of subsequent payments in a Bill that provides for 17 years duration of a patent in lieu of the 21 years proposed in the 1879 Bill. With respect to Mr. Head's suggestion, it seems, as far as I could follow him, that he thought there should be a sort of friendly Board to which an intending patentee could go and say in confidence, "I have invented this; do you think it is likely to answer?" Now it does appear to me, with all respect, that that is a thing that could not possibly work. I feel certain that that kind of paternal legislation would not do. Imagine a Board to which an intending litigant, in a civil action, could go and say, "I am thinking of bringing an action with respect to that right of way over my field. Do you think I am likely to succeed?" I am glad to find that, except on the subject of the scale of fees, on which I have already fully remarked, the Bill has the hearty approval of Sir Antonio Brady. I believe I have now, although in a very cursory manner, answered the various suggestions that have been made. With respect to that provision of our Bill for removing patents from the domain of the lawyer, I am glad to say that it meets, apparently, with the approval of those now in power. I say so because the announcement made to us is, not that the Government Bill of 1882 is to emanate from the Lord Chancellor or from the Attorney-General, but that it is to proceed from the Board of Trade. We have written to the principal persons interested in these matters, and have sent copies of the Bill to them, stating at the same time we hope that between now and the meeting of Parliament the Bill may receive such general approval that the Government may see their way to incorporate its provisions in the measures they propose to bring forward. With these observations, I conclude what I have to say, except this, that I have to thank you most warmly for the close attention you have paid to a subject which, although it is done, no oubt, of great importance, is, on the other hand, an extremely dry one. The question of the Patent-law is one I have studied for many years, and I, no doubt, have worked hard in the preparation of the Society of Arts' Patent Bill; but Dr. Siemens was pleased to give me far more credit than is my due, and omitted to tell you the share he and others have had in the work. He did not tell you that he was the chairman of the successive committees of the British Association that have sat on this very matter. It was the fact of finding myself in the position of chairman of the Society of Arts that led me to suggest that the course they have followed should be pursued by that Society, while we had the advantage of the assistance of many gentlemen who are members of the committee of the British Association. I trust the Committee of Recommendations will agree to the demand made, that the Patents Committee should be continued, and you may reply upon it that when the Government Bill is brought forward it will be thoroughly scrutinised, and we will do our best to make such alterations in it as will bring it towards the measure prepared with so much labour by the Society of Arts.

Mr. T. Hawkesley—You have all listened with much attention to the eloquent address of my friend Sir Frederick Bramwell. The subject is one in which I take a great interest, but it is far too complex for me to express my opinion upon it at the present period of the day. But I am sure you will all agree that Sir Frederick Bramwell is entitled to an enthusiastic vote of thanks. I therefore beg to propose your thanks to him from the chair.

Sir Frederick Bramwell—I am very much obliged to you for your vote of thanks. Let me say, in conclusion, that if we obtain a really good Patent Act I shall be more than rewarded for the continued pains I have bestowed on the question—the best reward I can get is to see a good Bill embodying the bulk of these clauses.

FREDERIC SAUVAGE.

The *Times* gives a sketch of the life of Frederic Sauvage, to whom the people of Boulogne having just erected a statue, as the inventor of the screw propeller. His claim to this honour rests on the fact that in 1832, hearing that the French Government proposed to build a number of paddle steamers, he was led to devise a better means of propulsion, and eventually he constructed a screw. Early in that year Sauvage exhibited to the Boulogne authorities his new invention, which was highly approved. As he was anxious to bring it under the notice of Government, he gave up his Boulogne residence and left for Paris, where he took out a patent for 15 years. The screw was acknowledged to have its advantages with small boats, but the Commissioners who sat by order of the Minister of Marine to report on it concluded that it would be of no use for large vessels. The English Government in 1835, it is stated by the *Times*, offered him a sum for the invention, on the condition that it was to become the exclusive property of England, but the inventor, who was at that time stricken down by poverty, would not consent. It is further said that Sir Francis Pettit Smith derived his first idea of a screw from a visit to Sauvage's workshop. In 1841, Sauvage made an agreement with a shipbuilder and an engineer for the construction of a steamboat, to which the screw was to be fitted, he giving the plans, while they carried them out, and at their own expense, but the agreement, owing to a technical misunderstanding, was badly worded. The boat was built and fitted, but not as Sauvage wished, and the two others took all the credit. The unlucky inventor, forsaken by all, after many years of toil, was in the year

1843 shut up in the debtors' prison at Havre, where he remained some time, but was eventually released through the instrumentality of Alphonse Karr, who had taken a deep interest in him. From the time he had set on foot his experiments with the screw, he had spent in the course of ten years about 80,000 francs (£3,200), in exchange for which he afterwards received from the State a yearly grant of 2,500 francs (£100). Driven to despair, and in deep misery, Sauvage, who was advanced in years, was conveyed in April, 1854, to the Picpus Asylum, where he passed the remainder of his life, dying at the age of 71. The townpeople of Boulogne, in 1872, through the Mayor, M. Auguste Huguet, had his remains removed from Paris and interred in the cemetery, where a monument surmounted by a bust was erected to his honour.

It is probable that Sauvage's claims will receive but little attention outside his own country. In England, it will be remembered, in 1770, James Watt, writing to Dr. Small, proposed to use one of his steam-engines to drive a screw for the propulsion of a ship. In 1776, the American, Bushnell, described a submarine boat, propelled by a screw. Trevithick patented a screw propeller in 1816; and before him, in 1800, Edward Shorter patented a propeller, which was afterwards, in 1802, tried on H.M.'s ships *Dragon* and *Superb*. In America, Stevens, in 1804, tried to propel a boat by a screw. In 1816, Millington described a screw with a very ingenious steering arrangement connected to it, and this was apparently the first of a great number of attempts which have been made in that direction; all, as yet, unsuccessful. From this date till the date of F. Pettit Smith's invention (1836), the records of the Patent-office show that many minds were working in the same direction. The point of Smith's invention was the placing of the screw propeller in the dead wood of the vessel, nor has it ever been claimed for Smith that he was the inventor of the screw propeller, though he was, there seems little doubt, the one to bring it into actual use. There seems little question that Sauvage did nothing more than was done by very many others—by Watt, Trevithick, and the rest—conceived a most valuable idea, but never carried it beyond the stage of a model.

THE MINERAL RESOURCES OF TURKEY.

Consul Wrench in a recent report states, with reference to the resources of Turkey, that although the country teems with mineral wealth of various kinds, they are left almost undeveloped, except in the case of some products which are elsewhere rare, but found abundantly and of great richness and purity in the Levant. The meerschaum from Eskishehir, in the district of Kutayah, still continues to hold its supremacy; in recent times both emery stone and chromate of iron have been exported from Turkey in increasing quantities, and now the markets of the world are mainly dependent on this country for supplies of these minerals. Manganese ores, crystalline pyrolusite of remarkable richness and purity, have also been to some extent exported of late years to Europe. Boracite has also become an article of considerable export from Panderma, in the Sea of Marmora, and the trade bids fair, at no distant period, to be one of great magnitude. This mineral is found near Yildiz, about 43 miles to the southward of Panderma. In 1868, a Frenchman obtained concession of a quarry of gypsum, only eight acres in extent, and from it he extracted annually from 3,000 to 4,000 tons of boracite, which he exported to France for many years as "plaster of Paris." The value of the boracite was £60 per ton, while the cost did not amount to more than one-tenth of the value. Subsequently the discovery of large deposits of borax in California, caused a temporary fall in its value to £28 per ton, but afterwards it rose to £40, at which figure it stands at present. When it was discovered that the so-called "plaster of Paris," from the quarry of Yildiz, was boracite, several persons commenced to "prospect" in the neighbourhood for boracite, with invariable success. It has been ascertained that this mineral occurs in nodules of large size in a stratum no less than 50 feet thick in the lower part of a lacustrine deposit of gypsum, 250 feet thick, of the tertiary period. The area of the deposit is believed to be fully 20 square miles, and it is almost surrounded by granite, basaltic, and volcanic rocks. In three places in the area basalt protudes to the surface, and two mineral springs flow from the opposite edges of the basin. The boraciferous stratum comes in view in one place at the base of some high land towards the central part of the area, and it was here that the first workings commenced twelve years ago, in the eight acres of ground already mentioned, and during that period they are said to have yielded £1,500,000 profit. From the large extent and thickness of the deposits, the supply of the boracite may be considered practically inexhaustible, and competent persons assume that the quantities existing here must be computed by millions of tons. The claims to almost the whole of these deposits of boracite is held by some Englishmen by right of discovery under Turkish law. Consul Wrench states that though it may be a bold prediction to make, yet there is ground for belief that Turkey in time will also become noted for its gold mines, as he has been informed by those who have been from the outset connected with the discovery of mines in Turkey, and who have acquired the most extensive knowledge on the subject, that "the country is one vast series of auriferous deposits." In some places ores have been found, some of them associated with tellurium worth from £2,000 to £6,500 per ton. Hitherto but one concession for an argentiferous gold mine in Turkey has been granted; this mine is situated near Serdjiller, about 12 miles from the Dardanelles. This mine consists of a quartz reef 40 to 60 feet wide, projecting several feet above the surface like a wall, for nearly half a mile in length, and extending from the summit of a mountain of micaschist and syenite 1,500 feet high, down its side to the valley below; there are several ancient galleries in this reef. On the summit are the ruins called "Kalé-Tath," so called from a prehistoric fortress constructed of rough blocks of stone. From the top of the reef near the summit, Consul Wrench, when on a visit to the mine, says that he struck off some pieces of quartz, which—though not a particle of the precious metal was visible to the naked eye—on being assayed, proved to be of the remarkable richness of 8 oz. 3 dwt. 10 gr. of gold per ton of ore. Another sample proved even richer, for the yield was 43 oz. 10 dwt. of gold per ton of ore; other samples ranged from 1 oz. 13 dwt. down to 19 dwt. 10 gr. of gold per ton of ore, together with a nearly equal quantity of silver, and the reef appeared auriferous throughout. A very great value appears to be attached to this mine on account of the size and richness of the reef, and the unusual facilities for working, as it can be commenced as an open quarry with a natural drainage, and an inclined plane for covering the ore to the base of the hills, where water power is available for crushing, and also from its proximity to a seaport, to which a good level road leads. The property is about 1,000 acres in extent, and one quartz reef is 100 feet wide in the ancient galleries, and there are others converging towards "Kalé-Tath" from different parts of the mountain. An attempt has recently been made to turn to account the extensive coalfields belonging to the State, but not with very great success, as in many cases, and more especially as regards the Heraclea coalfields, the Turks and Croats, who have hitherto worked the mines, have done so in the roughest and most primitive manner, without any scientific knowledge, so that most of the pits and galleries have fallen in, or are flooded, and are practically useless to anyone undertaking the works.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

COLOUR BLINDNESS.

By R. Brudenell Carter, F.R.C.S.

Lecture I.—Delivered Monday, May 16, 1881.

Introductory. Nature of colour vision generally. Solar light—its composition. The prismatic spectrum. Invisibility of certain elements of the spectrum to the colour-blind. Appearance of the combinations of the remaining elements. Varieties and definitions of the resulting colour blindness.

It has long been known to those engaged in the pursuit of natural philosophy, and, to some extent, also to the general public, that certain persons are so organised as not to possess the same completeness of colour sensation as the great bulk of the community. Until lately, however, defective colour vision was considered to be a somewhat rare condition, a matter for philosophical curiosity indeed, but of only slight practical importance. It has been reserved for our own time to discover that colour blindness affects rather more than four per cent. of the whole male population of civilised countries, and that it affects certain classes in a still greater proportion; while, at the same time, industries have sprung up, and have attained to considerable development, in which the employment of colour-blind persons may easily occasion, and indeed often has occasioned, great calamities. The safe working of railway traffic and of steam navigation is almost entirely dependent upon the use of colour signals; and for these signals the colours chiefly employed are red and green, the very two about which the colour-blind fall into perpetual error and confusion. There is a general consent among practical men that these two colours cannot be replaced for signalling purposes by any others; and hence it has become imperatively necessary to exclude the colour-blind from occupations in which the lives of large numbers of people may be offered up as sacrifices to their incompetency. There are, in Great Britain, about 9,200 men employed as engine drivers; and there must be, among these, about 400 who are colour-blind, and whose work is a source of never ending peril both to themselves and others.

It is my intention, in this preliminary lecture, to speak chiefly of the nature of colour blindness; and, for this purpose, it will be necessary to pave the way by speaking of the nature of colour vision. The many among my audience who are fully acquainted with the existing state of knowledge on this subject must be asked to pardon the introduction of elementary matter, which seems necessary to order to give any approach to completeness to my discourse.

The quality to which we give the name of colour depends entirely upon the kind of light which is transmitted through a coloured medium, or reflected from the surface of a coloured opaque substance. In order to make this clear, we must remember that we see surrounding objects only by virtue of the light proceeding from them, and that this light is derived, either directly or indirectly, from the sun. If we carry the matter a step farther, we find that what we describe as light is merely an impression made upon our eyes by vibration or wave movement; and that this wave movement occurs in an infinitely subtle fluid medium, called luminiferous ether, which pervades space, and fills the intervals between the molecules of all transparent substances. Just as water is a more mobile and subtle fluid than mercury, or air than water, or hydrogen gas than air, so this hypothetical ether is more subtle than hydrogen; and it is indeed so subtle that it transcends our knowledge entirely, except by its effects in the propagation of the waves of light. A study of the phenomena of light shows these phenomena to be of a kind which only wave movement can explain, and which bear a striking analogy to those produced by the visible waves of water, or by the invisible waves of air which we recognise under the name of sound. I must therefore ask you to picture to yourselves the whole universe as filled and pervaded with this infinitely subtle and mobile luminiferous or light-carrying ether; and to realise that what we describe as light is nothing more than a vibration or wave movement in this ether, just as sound is nothing more than a comparatively coarse vibration or wave movement in air. Between the wave movements of sound and those of light there are differences as well as resemblances, but the former do not at present fall within the scope of our notice.

In the propagation of wave movement, it must be remembered, the particles which form the wave do not themselves travel, but only oscillate. If we stand by the smooth surface of a pool of water, on which some corks are floating, and if we throw a stone into the middle of the pool, we shall initiate a violent wave movement, which will be quickly propagated in all directions from the centre of disturbance to the extreme margin of the water. The surface of this water will be thrown into alternate elevations and depressions, and these elevations and depressions will travel to the shore; but the water in which they occur does not travel, but only moves up and down. If we watch the floating corks, we shall see the whole mechanism of the process. The corks will bob up and down on the successive waves, but will retain their original places on the pool; and, when the wave movement subsides, the corks will be left where they were at first. If the propagation of the waves is checked by some obstacle, as by a wall bounding the pool, they will be turned back, and the secondary or reflected waves thus formed will intermingle with those which are still advancing from the centre,

and will produce a resultant or mixed movement which is unlike either of the two which went to its formation. Moreover, if the obstacle be at right angles to the line of propagation of the original waves, it will affect them in one definite way; and, if it be oblique to the line of propagation, it will affect them in another definite way: the resultant compound movements being different in the two cases.

Now the light of the sun—and for the sake of simplicity we will exclude artificial sources of light from our consideration—produces wave movement of the luminiferous ether; and this wave movement, when it is interrupted by an obstacle, is turned back or reflected from this obstacle in a certain definite manner, dependent upon the nature and position of its surface. The human eye contains a mechanism by means of which the light waves which enter it are re-arranged upon the nerve tissue subservient to vision, in a reduced reproduction of the pattern in which they left the obstacle, and so we are said to see the objects around us. What is meant by seeing, is that the vibratory movement of the luminiferous ether, being first rearranged within the eye according to the way in which it was reflected from the visible object, produces corresponding molecular movement in the nerve tissue, and this movement becomes the subject of consciousness. All vision depends upon the nerve tissue being made to vibrate in unison with the vibrations which constitute light.

The light which we receive from the sun is white or colourless; and hence, if this light were pure and unmixed, so that it was reflected from all surfaces precisely as it fell upon them, subject only to more or less diminution of quantity from absorption or in transmission, the effect would be that the pattern or picture formed within the eye would exhibit differences of light and shade alone. The visible world would be deprived of colour, and would be reduced to the level of a "black and white" exhibition.

In reality, however, the solar light is a mixture produced by the blending together of three different rates and magnitudes of vibration. The waves of largest size and of the slowest oscillation, when we receive them alone, produce a nerve movement which excites the sensation that we call red. The waves of intermediate size and quickness, when we receive them alone, produce a nerve movement which excites the sensation that we call green, and the smallest and most rapid waves produce a nerve movement which excites the sensation that we call violet. For the foundation of this discovery the world was indebted to the genius of Newton.

Material substances may be roughly divided, in respect of light, into two classes; those which permit it to pass through them, and which are termed transparent, and those which obstruct its passage, and are termed opaque. We may probably assume that the interstices in the structure of the former are more fully charged with luminiferous ether, and are more favourable to its freedom of movement, than in the latter; but there is probably no solid, however transparent, in which the freedom of light vibration is so great as in air. We may assume, therefore, that light, in passing from air into any transparent substance, is retarded as regards the rapidity of the wave propagation; but whether it is modified in any other manner will depend upon circumstances, to which I shall now have to call your attention. Mr. Ladd will be good enough to throw a beam from the electric lamp upon the screen; and you will see that the ether waves pass through the air unchecked, in a straight line, and make a luminous band, corresponding in shape to the slit of the lamp, upon the screen. He will now interpose a plate of glass, holding it at right angles to the course of the ray; and you will perceive that the luminous wave movement is continued through the glass almost as if it were not there. As soon, however, as he turns the glass obliquely to the ray, you will see a difference. The light waves no longer strike the surface of the glass fairly and fully, at right angles to their course, but obliquely, so that one end of each wave reaches the surface before the other. The consequence of this is that one end is more retarded than the other, and that the course of the wave is bent or turned. This is called refraction, and you will observe that, whereas the plate of glass held at right angles leaves the position of the bright line on the screen unchanged, the plate held obliquely bends the beam of light, and alters the position of the line.

Now, although all light is thus bent or refracted when it falls obliquely upon the surface of a transparent medium, the degree of the refraction depends very much upon the magnitude and speed of the wave movement; being much greater for small and rapid waves than for large and slow ones. Hence, by means of a prism, an appliance for producing a high degree of refraction, we are able to split up the solar light into its component parts, and to exhibit them separately. Mr. Ladd will now rekindle the lamp, and will place a powerful prism in the track of the beam, so as to produce what is called the prismatic spectrum. This is the immortal discovery of Newton.

The first thing you will observe with regard to the prismatic spectrum is that, although the light as a whole is bent out of its course, the rays which produce upon your eyes the impression of violet are those which are bent the most, those which produce the impression of green are bent in less degree, and those which produce the impressien of red are bent least of all. This is in accord with the difference of the amount of refraction which is incidental to the difference of wave length, and explains the principle upon which the splitting up of the solar light into its component parts depends.

The next thing to be observed is that the spectrum is not limited to the three colours which I named, red, green, and violet, but that it contains others also. We may now abandon the electric light, and turn to a pictorial representation of the original Newtonian spectrum, as it may be obtained from sunlight in the day time. You will see that the order of colour in this spectrum is as follows, red, orange, yellow, green, blue, indigo, and violet. It was at first supposed that these seven colours were all simple or primary; but farther research established the fact that four of them are secondary, or mixtures produced by the overlapping of the margins of the rest. Even after this was fully admitted, it was for a long time not possible to ascertain with certainty which colours were primary; and an erroneous conclusion was

first arrived at upon the point. It was reserved for the late Professor Clerk Maxwell to clear up all doubt upon this subject, and to prove beyond question that the true primaries are red, green, and violet, or, as he called it, blue. Orange is a mixture of red and green with the red in excess; yellow a similar mixture with the green in excess; while blue and indigo are mixtures of green with violet. The difficulties which stood in the way of an accurate determination of the primaries were largely due to an element of confusion introduced by the use of pigments for the purposes of experiment. People who were accustomed to mix blue paint and yellow paint to produce green, found it difficult to believe that the green of the spectrum was anything more than a mixture of the blue and yellow by which it was bordered; but as Mr. Ladd will show you, an admixture of the blue and yellow of the spectrum does not produce green, but white. The blue light being a compound of green with violet, and the yellow light being a compound of green with red, the two together afford the three primaries, which combine to form white. In the paints, on the contrary, the material which appears blue absorbs and quenches red—while the material which appears yellow absorbs and quenches violet; so that only the green, which is common to both, is reflected unchanged to the spectator from the mixture.

We have now arrived at the point that sunlight consists of three colours, or, more properly, of ether in three different states of vibration; and my next proposition is that nearly all substances have differences of behaviour in relation to these three states respectively. Speaking of light generally, we may say that it is affected by matter in three chief ways. It is either reflected from surfaces, or transmitted through substances, or absorbed and quenched within their mass, and it undergoes all these operations in some degree in every case. To say that a surface is perfectly white in sunlight is a way of stating that it not only reflects back to the spectator a large amount of the light which it receives, but that it also reflects it in unchanged proportion of its constituent parts, turning back long, short, and medium waves with absolute impartiality. To say that a surface is black in sunlight is a way of stating not only that it absorbs nearly all the light it receives, and quenches this light by arresting the wave movement within its mass, but that it also absorbs and quenches impartially with no distinction between wave lengths. To say that a surface is red, is to say that it absorbs and quenches the green and violet rays, but that it permits the red to be reflected, and the same applies to the other primary colours also. A green surface is one which reflects green rays while it absorbs and quenches red and violet, and a violet surface is one which reflects violet, but quenches red and green. In order to illustrate this, Mr. Ladd will once more throw the prismatic spectrum on the screen. A piece of white paper, wherever we hold it, reflects the colour which falls upon it, and appears red, yellow, green, or blue, according to its position. A piece of black paper, wherever we hold it absorbs the light which falls upon it, and appears black without reference to its position. A piece of red ribbon, held in the red end of the spectrum, receives only light which it is capable of reflecting, and shows its proper colour with unusual brilliancy; but, if we carry it into the green portion, it receives nothing which it does not absorb, and it appears entirely black. A piece of green ribbon, on the other hand, is vivid in the green portion, and appears black in the red.

We thus arrive at the fact, that the apparent colour of any object is due to the selective power which it posseses of quenching certain elements of white light, while it reflects the rest, and the seeming difficulty of reconciling the infinite variety of colour with the fewness of the three elementary or primary colours will disappear as soon as we consider how these three primaries are produced. Very large numbers can hardly be realised by the mind, and there would be no advantage in stating the figures which I am about to give with entire exactness, even if that were attainable. I will be content to say that the lengths of the waves of light are such that about 35,000 waves of red, about 50,000 waves of green, and about 60,000 waves of violet, would be comprised within the length of a single inch. If we take the medium, the 50,000 waves in an inch as the basis of a farther calculation, and consider that the speed of the propagation of light is about 190,000 miles in a second of time, we may find by simple multiplication that the actual number of the waves which produce the sensation of light amounts to hundreds of billions in a second. We must, therefore, regard each primary colour as being composed of an infinite number of units, and the number of possible combinations from billions of units of red, billions of units of green and billions of units of violet, if not absolutely incalculable, is at least inexhaustable. It must be remembered, moreover, that these combinations do not possess any obvious character to declare them for the mixtures which they are. The simple mixtures, such as orange, yellow, blue, and indigo, were long believed to be themselves primaries, and the effect of a mixture is not a question of the mere addition or subtraction of a tint, but is rather a modification of the whole character of the aggregate resulting wave movement by the various clashings, blendings, and interferences of one series of waves with the rest. The spectator who looks down from a favourable position upon the "multitudinous laughter" of the ocean, and who sees upon its surface a movement which is never the same, may realise from that magnified representation something of the possible diversity which the endless combinations of the waves of colour may be equally capable of producing.

Excepting in the prismatic spectrum, carefully obtained under specified conditions, we never see a primary colour in a state of purity. The colours of all natural objects are mixtures; and even those which appear identical with the pure red or the pure green may be easily shown to be mixtures by careful experiment. If we take such an object as a geranium petal, which we should call almost pure red, and look at it by sunlight, a portion of that sunlight is reflected back to us absolutely from the surface of the petal, and that portion, which has not at all penetrated into the tissue, is reflected unchanged, or as white light. The light

which penetrates some little way into the petal, and which is then reflected, is first deprived of most, although probably not of all, of its green and violet. Even if the deprivation of green and violet were complete, the total of the reflected light would still be an admixture of the pure red from the deeper tissue of the petal with the white light turned back unaltered from its surface; and the latter, of course, would contain all the elements of the spectrum. Even if the red were a pure colour, what we should see on looking at the petal would be an admixture of red with white.

The same thing may be illustrated, in a simple manner, by the colours of transparent substances. When we say that a piece of glass is red or green, we must not be supposed to imply, otherwise than when speaking roughly and inexactly, that it transmits the red rays or the green rays and quenches all others. What it does, as a matter of fact, is to transmit a mixture, in which red or green is predominant, but from which other colours are not excluded. Mr. Ladd will throw the electric beam once more upon the screen, and will then place before the lantern a piece of red glass, such as is used for the danger signals on railways. You see the white spot is transformed into what you would call a red one; and you would be inclined to say that the light falling upon the screen was red light only, the glass having intercepted all the rest. We will test this by the interposition of a prism, which breaks up the so-called red light into its component parts, and shows us that it contains also a certain quantity of violet. We will now repeat the experiment with the green glass used for railway lanterns; and here again we shall find that the green light, as we should at first be inclined to call it, has by no means been deprived of all admixture with other colours. In other words, the colours which we call, in common parlance, red or green, are not accurately described by this form of expression. In reality, they are mixtures, in the composition of which red or green is no more than the predominant ingredient. To this element in the question I am anxious especially to direct attention, because we shall have to return to it hereafter.

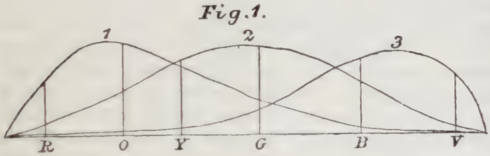
If we pass on now to the effects of these colours upon the sense of sight, we shall find that the healthy human eye, as it is organised in the great majority of people, not only recognises the quantitative arrangement of the light in the pictures which are formed upon its retina or nervous screen, but also recognises differences in the rapidity and amplitude of the wave movement of which this light is composed; seeing, in other words, not only form and light and shade, but colour also. There are others, very few in number, whose eyes are so organised that they take no note of the rapidity or magnitude of the vibrations, and who are not conscious of any differences of colour at all, seeing nothing but light, and shade, and form. To such people, to repeat my former illustration, the world which we inhabit is a black and white exhibition. There are others, and as we shall see presently, a considerable number of them, who are insensible to one of the three primary colours, generally either to red or green, but occasionally to violet, and these people see all colours differently to their fellows, because they lose in every mixture the effect of one of the elements which enters into its composition. For instance, a person who was blind to red, or looking at the geranium petal of which I have already spoken, would be unconscious of the large amount of red light reflected from it, as if this was not there, and would see only the small amount of green and violet contained in the white light reflected from the absolute surface. The amount of this white light would probably be small in relation to the extent of the surface, and so this surface, appearing dimly lighted, would look dingy and dark. Hence, a red-blind person will often select a deep olive green, or a dark chocolate brown, as a match for the most vivid red which can be shown to him.

The nervous apparatus of the eye, which is subservient to the sense of vision, is an expanded surface formed of the terminations of fine filaments of two obviously different kinds, called respectively the rods and the cones of the retina. The cones are most abundant in the central portion, where vision, both for form and colour, is most acute; and the rods are most abundant in the lateral parts, where vision, both for form and colour, is comparatively defective. It was conjectured by Dr. Young, whose conjecture, in a somewhat modified form, has been adopted by Helmholtz, that the cones may be of three distinct kinds, one of which responds to sensations of red, a second to sensations of green, a third to sensations of violet; and that, in the persons who are blind to one colour, one of these varieties may be paralysed, dormant, or wanting. It seems to me that there are certain difficulties in the way of the acceptance of this hypothesis; concerning which I will go no farther than to repeat Faraday's famous formula, "it may be so." Another way of stating the facts is to remind you that tuning forks, or strained strings tuned to a certain pitch, may be thrown into vibration by wave movement communicated to the air by other forks or strings tuned in a similar manner; while those which are tuned differently remain unaffected, although they would at once respond to vibrations of the pitch fitted to excite them. Mr. Ladd has here a pair of tuning forks with which to exhibit this effect; and you will observe that, when one of them is struck, it throws the other into vibration. He will next alter the pitch of one of the forks by loading one of its prongs with a lump of wax; and you will observe that, in this state, it remains unaffected by its fellow; while, if the second fork were to be loaded precisely to the same extent as the first, its power to produce vibration of the first would be restored. Now there is a good deal of analogy between the waves of light and the waves of sound; and, just as strings or tuning forks will not take up some particular rate of air vibration, to which they are not adapted by their own state of tension, so very possibly the nerve cones are not capable of being thrown into vibration, or of being physically affected in the usual manner, whatever that may be, by wave movements of the luminiferous ether of some given speed and magnitude. Either conception, the idea that there are distinct organs for each colour, or the idea that a certain state of nerve tension is required for the perception of each colour, will serve as a hypothesis around which to

group the facts; and these, as we shall see presently, are very curious and interesting.

As I have just stated, Professor Helmholtz, in his account of the theory of colour sensation propounded by Young, assumes that there are in the normal eye three kinds of nerve fibres, that stimulation of fibres of the first kind produces the sensation of red, that stimulation of the second kind produces the sensation of green, and that stimulation of the third kind produces the sensation of violet. He assumes also that homogeneous or monochromatic light excites these three kinds of fibres in varying degrees according to the wave lengths. The red-perceptive fibres will be most stimulated by light of the greatest wave-length, and the violet-perceptive by light of the smallest wave-length. It must also be assumed, however, that each colour excites all three kinds of fibres, although it excites one kind much more strongly than the others. Helmholtz illustrates this by the diagram shown in Fig. 1,

Fig. 1.



in which the colours of the spectrum, omitting the indigo, are arranged in a row from red to violet, and in which the three curves represent the intensity of stimulation of the three kinds of fibres. The curve marked 1 represents the stimulation of the red-perceptive fibres, the curve marked 2 represents the stimulation of the green-perceptive, and the curve marked 3 represents the stimulation of the violet-perceptive fibres.

Simple *red* strongly stimulates the red-perceptive, less the other two: sensation, *red*.

Simple *yellow* stimulates moderately the red and green perceptive, feebly the violet: sensation, *yellow*.

Simple *green* stimulates strongly the green-perceptive, much less the other two: sensation, *green*.

Simple *blue* stimulates moderately the green and violet perceptive fibres, feebly the red: sensation, *blue*.

Simple *violet* stimulates strongly the violet-perceptive, feebly the other fibres: sensation, *violet*.

Equally strong stimulation of all the fibres gives the sensation of white or whitish colours.

Professor Helmholtz is fully aware of the difficulties which impede the acceptance of Young's hypothesis of there being three kinds of fibres, and he suggests, as a possible modification, that three separate functions may be discharged by each fibre. Whether this be so, it is not at present either possible or very important to ascertain; and either of the foregoing hypotheses, or the hypothesis of variations of tension rendering the fibres incapable of responding to certain rates of vibration, will serve almost equally well to explain the phenomena which have been observed.

In speaking of these phenomena, Professor Holmgren has made use of Helmholtz's diagram, and has modified it in such a manner as to exhibit the effects of colour blindness. I could not present the whole question to you in any other way so well as by quoting his words, which I take from the American translation published by the Smithsonian Institution. He says:—

"To explain the abnormal sense of colours by the theory of the normal, we can, in advance, suppose various possibilities. Let us conceive that one of the three fundamental perceptions is wanting, or that one of the primitive colours is absent: it is clear that the whole chromatic system will be upset. It is evident, therefore, that this system must be completely different, according to the absence of one or the other of the three primitive colours. It is virtually just in this way that it has been attempted to explain cases of a strongly marked defect in the chromatic sense, or genuine types of blindness to colour, found in real life. The term colour-blindness has been justified by this, as it indicates in each case a genuine blindness to one of the primary colours. In this way, therefore, we distinguish, according to the kind of element wanting, three classes of blindness: namely, red-blindness, green-blindness, and violet-blindness."

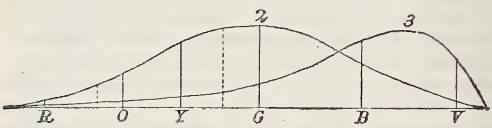
According to the theory, blindness to red is due to the absence or paralysis of the organs perceiving red. Red-blindness, then, has but two fundamental colours, which, adhering strictly to the theory, are green and violet. The curves in the second diagram distinctly show what aspects the various kinds of light must have for a person who is placed in such a condition.

The red of the spectrum, which feebly excites the perceptive organs of green, and scarcely at all those of violet, must appear to the red-blind as a saturated green of a feeble intensity, more saturated than green as visible to the normal eye, for into this sensible portions of the other primitive colours enter. Feebly luminous red, which affects the perceptive organs of red in a normal eye sufficiently, does not on the other hand sufficiently excite the perceptive organs of green in the red-blind, and it therefore seems to them black. The yellow of the spectrum seems to them a green, saturated and intensely luminous, and, as it constitutes the precisely saturated and very intense shade of that colour, it can be understood how the red-blind select the name of that colour, and call all those tints that are, properly speaking, green, yellow. Green shows, as compared with the preceding colours, a more sensible addition of the other primaries, and it consequently appears like a more intense but whitish shade of the same colours as yellow and red. The greatest intensity of light in the spectrum, according to Seebeck, does not appear to the red-blind to be in the yellow region, as it does to the normal eye, but rather in that of the blue green. In reality, if the excitation of the perceptive organs of green, as it is necessary to assume, is strongest for green, the maximum of the total excitation of the red-blind must be found slightly toward the blue side, because the excitation of the organs perceiving violet is then increased. The white of the red-blind is naturally a combination of their two primitive colours in a determinate proportion, a combination which appears blue-grey to the normal sight; and this is why the red-blind regards as grey the transition colours of the spectrum from green to blue. Then the other colour of the spectrum, which the red-blind call blue, preponderates, because indigo-blue, though somewhat whitish according to their chromatic sense, is to them,

owing to its intensity, a more evident representative of that colour than violet.

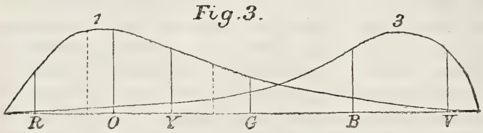
This description of the manner in which the red-blind form a conception of the different kinds of light of the spectrum is assuredly a conclusion logically deduced from the theory; and it accords so well with the experience acquired in examining the colour-blind, that it might serve to corroborate and support the theory. We will simply add one point for our especial practical purpose, or rather will emphasise one point. As a matter of fact, it is clear that red light and green light excite one and the same element in the colour-blind. Rays which are respectively red and green, or objects which are respectively red and green, to the normal sense, must seem to a red-blind person to be of the same colour; and if, in especial cases, he knows how to discriminate between them, his judgment is simply guided by the intensity of the light. The intensity of the light is much more feeble, as shown by diagram 2, in red than in green. If then, a red-blind individual finds that a red and a green tint are exactly alike, the green would, to a normal eye, be much less intense than the red. This is distinctly shown by the vertical dotted lines between R and O, and between Y and G, in Diagram 2, and is also entirely confirmed by experience.

Fig.2.



Green-blindness derives its origin, according to the theory, from the absence or paralysis of the perceptive elements of green. The green-blind has therefore only two fundamental colours, red and violet, and the spectrum for green blindness should be constructed as in diagram 3. In such a

Fig.3.



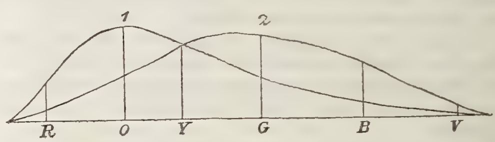
case the red of the spectrum, which strongly excites the perceptive organs of red, and but very faintly those of violet, must appear to the green-blind as an extremely saturated red, but of a light somewhat less intense than the normal red, which is comparatively more yellowish, as green forms a part of it. The orange of the spectrum is again a very saturated red, but much more luminous. Yellow is undoubtedly a more intensely luminous red than the red of the spectrum, but, on the other hand, more whitish, because a sensible portion of the other primitive colour enters into its composition.

Green, with its shades inclining to yellow and blue, ought, correctly speaking, to be a saturated purple, and with a mean intensity of light; but it is the white or grey of the green-blind, being composed of almost equal parts of the two remaining primitive colours.

The *Blue* is an intense violet, but a little less saturated than indigo, which is more strongly luminous and more saturated. Violet is a little less intense, but more saturated than normal violet. The tints most luminous, and at the same time most saturated, which must constitute the types of the primitive colours of the green-blind, are orange, or its immediate neighbour in the spectrum, red, and indigo blue. Now orange is a colour which, in ordinary language, especially amongst the uncultivated and unpractised, is indiscriminately called red and yellow: this fact explains why the green-blind denominate their first primary colour sometimes "red" and sometimes "yellow." We will add to this description the same remark that has been made about red-blindness. In green-blindness the same organ is found affected by the red and by the green of the spectrum. Red and green are therefore perceived by the green-blind in the same way, or, in other words, are to him exactly the same colour. In cases where he succeeds in distinguishing them, it is by the aid of the intensity of the light; but, with regard to this intensity of light, it is the opposite of what occurs in the case of the red-blind. A green tint which to the green-blind appears exactly like a red one would to a normal sense of colour be sensibly more luminous than the red. This is shown by the dotted vertical lines between R and O, in Diagram 3, and also by those between Y and G, and is confirmed in every respect by experience.

Violet-blindness is due, according to the theory, to the absence or paralysis of the elements perceiving violet. The two primitive colours of the violet-blind are then, according to the theory, red and green; and their spectrum must be represented as in Diagram 4. In this condition the red is a

Fig.4.



purer red colour, not yellowish, than normal red, but still less saturated. The more it inclines towards orange, the more strongly luminous it is, but it is at the same time less saturated, more whitish. The yellow is, as it were, a combination of almost equal proportions of the fundamental colours which form white. Green is a strongly luminous but whitish green, which, in tending towards the blue, becomes more and more saturated, so that greenish blue must be the type of these hues. The *Blue* is a green of moderate luminosity, and strongly saturated; and violet is green very feebly luminous, but also saturated in a much higher degree than the normal. A violet strongly luminous is sufficient to induce this green, but a feeble violet, although very sensible to the normal eye, is black to the colour-blind in question. It is plain that the violet-blind, whose primitive colours are red and green, do not confuse these colours.

Besides the cases arranged under the three foregoing heads, in which one colour is absolutely expunged from the spectrum, there are others in which the perception of one colour, although not

entirely wanting, is yet deficient in acuteness; and this deficiency may vary greatly in degree. There are also cases in which there is a deficiency of acuteness in respect of all colours, so that, in a diagrammatic representation of the state of function of such an eye, all three of the curves would be drawn lower than the normal, although no one of them would be absent. Such a condition would imply, manifestly, a diminished acuteness of perception for white light, that being formed by the union of the rest, and it is found in the cases of so-called night blindness, the subjects of which, although able to fulfil ordinary avocations in the daylight, almost lose vision on the approach of dusk. There can be no difficulty in perceiving that colour blindness, or rather defective colour vision of this kind, may merge insensibly, as in the progress of disease, into absolute loss of vision.

In the perfectly healthy eye the power of distinguishing colours varies greatly with the part of the field of vision from which the colour proceeds. In order to examine the lateral parts of the field of vision we use an instrument called a perimeter, of which I here exhibit one of the forms. The eye under examination is made to look steadily at this central point, while a second object is made to glide along this arc, from its termination towards its centre, and the arc is shifted from one meridian to another as may be required. Now the second or moving object first becomes visible in the outer parts of the field, solely by form and not at all by colour, which cannot be recognised. Its appearance depends mainly upon whether it be lighter or darker than its surroundings, and hence the moving object, of whatever colour, will appear black or grey on a light ground, and white or grey on a dark ground. As the object advances it enters a zone of the field of vision which is sensitive to violet, next a zone which is sesitive to green, and sensitiveness to red only commences at a still later period, while full sensitiveness to all three of the primary colours exists only in the central portion of the retina. With a little practice, it is not difficult to hold a red object in such a position that its form is still visible, while its colour ceases to be distinguished.

Upon the basis of the foregoing facts, Professor Holmgren has proposed to divide and classify colour blindness as follows; and his proposals have received the general assent of those engaged in the investigation of the subject:—

"1. Total colour-blindness, in which the faculty of perceiving colours is absolutely wanting, and where the visual sense consequently can only perceive the difference between darkness and light, as well as the different degrees of intensity of light.

"2. Partial colour-blindness, in which the faculty of certain perceptions of colour, but not of all, is wanting. It is sub-divided into—

"1. Complete colour-blindness, in which one of the three fundamental sensations, one of the three perceptive organs of colour in the retina, is wanting or paralysed, and in which, consequently, the coloured visual field has but two ranges. This group includes three kinds, namely:—

(*a.*) Red-blindness.
(*b.*) Green-blindness.
(*c.*) Violet-blindness.

"2. Incomplete colour-blindness, where one of the three kinds of elements, aad perhaps all, are inferior in excitability or in numbers to those of the normal chromatic sense. Incomplete colour blindness exhibits, like the normal sense, three zones in the visual field, but is distinguished from it by an unusually small central field. This group includes the whole of a series of different forms and degrees; a part of which, comprising the superior degrees, might be called incomplete red-blindness, or incomplete green-blindness, or incomplete violet-blindness, and constitutes the transitions to the corresponding kinds of complete colour-blindness; while another part, comprising the inferior degrees, which we call a feeble chromatic sense, constitutes the transition to the normal sense of colours."

Of the varieties thus indicated, two, the complete red-blindness and the complete green-blindness, are overwhelmingly more important than all the rest, and to them, in the subsequent lectures, I shall have chiefly to direct yonr attention. The violet blindness is a comparatively rare condition, and, in the present state of industry, we are not aware that it is a source of harm or danger to anyone, although it may possibly sometimes be responsible for errors of colour in pictures, in decorations, and in dress. The complete forms of red and green blindness, on the contrary, have been contributory to much destruction of life and property in railway travelling and in steam navigation; and are sufficiently common to have a pressing interest for us all. I may perhaps add, in this place, that whereas there is nothing intrinsically impossible in the supposition that incomplete colour-blindness may be improved by cultivation and practice, there is great weight of evidence, as well as all analogy and probability, in support of the belief that complete colour-blindness is an unalterabie condition, upon which educational efforts are simply thrown away. If there are no nerves capable of responding to a given stimulus, the mere repetition of the stimulus will have no tendency to create them.

MISCELLANEOUS.

MEMORIAL TABLETS.

In the year 1864, a letter appeared in this *Journal* (Vol. 12, p. 362) from a correspondent, who suggested that the Society of Arts should offer a prize or prizes for designs of memorial tablets to be affixed to houses associated with distinguished persons, and in the same year a series of suggested inscriptions was reprinted from the *Builder*. The subject having been brought under the notice of the Council, a committee was appointed in 1866 to consider and report how the Society might promote the erection of statues or other memorials of persons eminent in Arts, Manufactures, and Commerce; and, at the first meeting of the committee, on May 7th, Mr. George C. T. Bartley submitted some memoranda on the proposal to place labels on houses in the metropolis known to have been inhabited by celebrated persons. Subsequently, Mr. Bartley prepared an alphabetical list of names of those who were worthy of record, which was printed in several numbers of the *Journal*. In 1867, the first tablet was erected by the Society in Holles-street, Cavendish-square, on the house where Byron was born. Other tablets were soon afterwards put up,

and the erection of these memorials has been continued to the present time. In 1872, Mr. Newmarch, F.R.S., wrote a letter to the Council (see *Journal*, (Vol. 20, p. 492), suggesting certain names, some of which have been commemorated, and Mr. H. D. Pochin contributed £25 for the purpose of carrying out these suggestions. Six new ones, in commemoration of Barry, Hogarth, Newton, Peter the Great, Sheridan, and Walpole, have been erected during the present year. The complete list of tablets to the present time is as follows:—

James Barry	36, Castle-street, Oxford-street.
Edmund Burke	37, Gerrard-street, Soho.
Lord Byron	16, Holles-street.
George Canning	37, Conduit-street.
John Dryden	43, Gerrard-street.
Michael Faraday	2, Blandford-street, Portman-square.
John Flaxman	7, Buckingham - street, Fitzroy-square.
Benjamin Franklin	7, Craven-street, Strand.
David Garrick	5, Adelphi-terrace.
George Frederick Handel	25, Brook-street.
William Hogarth	30, Leicester-square.
Samuel Johnson	17, Gough-square, Fleet-street.
Napoleon III.	3A, King - street, St. James's.
Lord Nelson	147, New Bond-street.
Sir Isaac Newton	35, St. Martin's-street.
Peter the Great	15, Buckingham - street, Strand.
Sir Joshua Reynolds	47, Leicester-square.
Richard Brinsley Sheridan	14, Savile-row.
Mrs. Siddons	27, Upper Baker-street.
Sir Robert Walpole	5, Arlington-street.

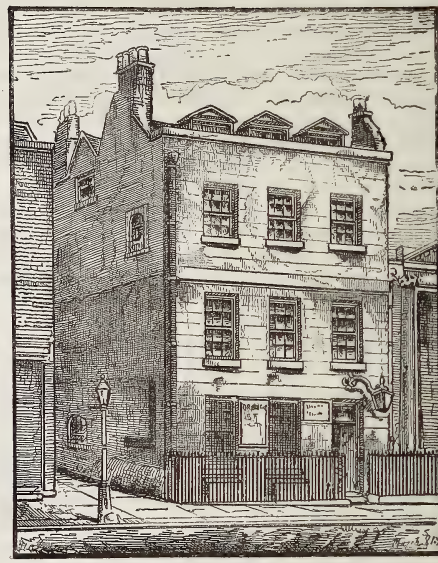
The house in Leicester-square, upon which a tablet in memory of Hogarth has been erected, is occupied by Archbishop Tenison's school, for which the house was re-built. The original building, in which Hogarth lived for several years was long known as the "Sablonière Hotel." John Hunter lived next door after Hogarth's death. Of the four worthies who were intimately connected with Leicester-square, viz., Hogarth, Hunter, Newton, and Reynolds, and whose busts are now set up at the four corners of the enclosure, three will be found in the above list.

It is proposed to give in various numbers of the *Journal* representations of the houses upon which memorials have been set up, and the blocks for the four in the present number have been kindly lent by Messrs. Dawson, of the Typographic Etching Company.

The house in St. Martin's-street, which is now occupied by the schools attached to the Orange-street Chapel, is in much the same condition as when Sir Isaac Newton lived in it, from 1710 to 1727, except that the old red bricks have been covered with stucco, and an observatory on the roof has been taken away within the last few years.

Flaxman had several London residences, but the house in Buckingham-street, Fitzroy-square, is the one with which he is most intimately associated, as he lived in it during the prime of his artistic career. He went there in 1796, when he returned from Rome, and there he died in 1826, being buried in the ground adjoining old St. Pancras church, and belonging to the parish of St. Giles-in-the-fields. The house is on the south side of the street, close by Great Titchfield-street.

Canning's house, on the south side of Conduit-street, is greatly changed since the great statesman lived in it. It originally formed a wing of Trinity Chapel, which has been swept away within the last few years. This chapel was the successor of the chapel on wheels which was used at the Hounslow camp in the reign of James II., and was subsequently brought up to London. It is shown in Kip's view of old Burlington-house as standing in the fields at the back of that house. When Conduit-street was built, a chapel was erected on the south side to supersede the chapel on wheels. The house on the west side of the chapel, where Canning



Newton's House, St. Martin's-street.

lived for a time, was subsequently inhabited for many years by the famous physician, Dr. Elliotson, F.R.S. After his death, the front was altered, and a large shop window made, as seen in the accompanying figure. It is now in the possession of Mr. Streeter, the jeweller.

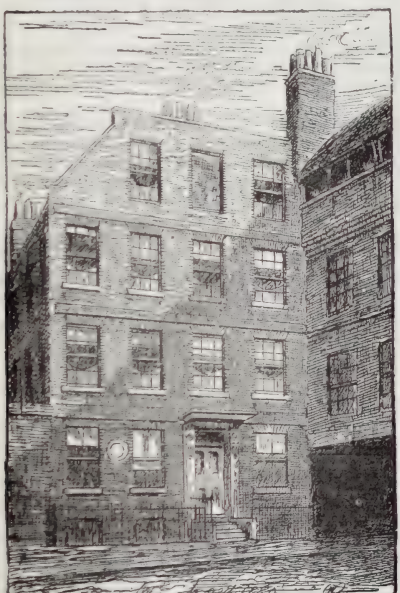
Flaxman's House, Buckingham-street.

Dr. Johnson had so many residences in London that there is some difficulty in choosing the one that is most interesting to us. The house in Gough-square has special claims to attention, as it was there that the great lexicographer chiefly compiled his dictionary. The garret, with its slanting roof, in which his amanuenses worked, and his own study are still to be seen. Johnson himself, in his "Life of Milton," observes, "I cannot but remark a kind of respect, perhaps unconsciously, paid to this great man by his biographers; every house in

which he resided is historically mentioned, as if it were an injury to neglect naming any place that he honoured by his presence." Emboldened by this expression of opinion, Boswell one evening, in the year 1779, ventured

Canning's House.

to ask Johnson the names of some of his residences, and he obtained the following list, which he printed in his "Life of Johnson":—(1) Exeter-street, off Catherine-street, Strand; (2) Greenwich; (3) Woodstock-street, near Hanover-square; (4) Castle-street, Cavendish-



Johnson's House.

square, No. 6; (5) Strand; (6) Boswell-court; (7) Strand again; (8) Bow-street; (9) Holborn; (10) Fetter-lane; (11) Holborn again; (12) Gough-square; (13) Staple's-inn; (14) Gray's-inn; (15) Inner Temple-lane, No. 1; (16) Johnson's-court, No. 7; (17) Bolt-court, No. 8. In this last place he died in 1784.

In April, 1879, the Corporation of the City of London were asked to co-operate in this work, and to undertake the erection of suitable Memorial Tablets within the City boundaries. The matter was referred to the City Lands Committee, with which body the Secretary has had several communications with respect to the localities suggested for memorials, the result being that the committee agreed to erect such tablets within the City boundaries.

HORTICULTURE IN ALGERIA.

Mons. V. Ch. Joly has communicated a paper on this subject to the Societé d'Horticulture of Paris, of which the following is an abstract:—

The more we advance towards the north, the more we find the taste for horticulture developed, just in the same proportion as where nature does least, necessity will always render man active and industrious. Before speaking of the production of fruits, flowers, and trees, I ought to mention the great question which preoccupies Algeria, namely, the water question; without water, no vegetables, no animals, no colonisation is possible. As there is no stream with a regular course, water is a question of life and death; mere watering is of no use, it must be constant and thorough irrigation. Rain falls only during four months, consequently it is dry for the rest of the year, and this dryness prevents the cultivation of quinine, coffee, indigo, and tea.

The destruction of the forests has done here, as elsewhere, incalculable mischief, and the planting of trees is an urgent necessity. The *Eucalyptus* would render great service. In poor soil the family of the acacias offers species which, besides furnishing firewood, would give an industrial product of great value; by judicious planting in from ten to fifteen years, the climate, now very variable, would be rendered more equable, the springs would be increased, immense pasturages would be restored, and the native population now necessarily nomadic would become settled, and the European element would be more constant. The ruins so frequently met with show that the country was at one time populous, but the destruction of forests led to the destruction of animal and vegetable life. The principal trees met with in the public gardens are the date, Bourbon palm, the *Sabal*, the *Chamærops*, the *Caryota*, the *Areca sapida*, the bamboo, the banana, the *Dracœna draco*, the yucca, the aloe, the *Agave*, besides the *Eucalyptus*, and the plane tree. These last two play a great part in the plantations of new villages, where the engineers form broad boulevards, as they there form an enclosure which rapidly protects the inhabitants against a torrid sun. The *Eucalyptus* especially is the tree of health for low and damp grounds, on account of its great power of evaporation, as well as for its resinous juices; it grows from six to ten feet in height in one year. The temperature and moisture should always be considered as from non-attention to these important factors great waste often occurs, thus the fruit trees of the temperate zone perish quickly in Algeria, while the trees of the South of France, the almond, the jujube, pomegranate, fig, and medlar, ripen two months earlier than in France, and are of the first quality.

Until now, the principal centre of horticultural production has been Algiers and its suburbs. Everywhere irrigation is applied, the water being raised by rough homely instruments, which the labourers like, as they can make and mend them themselves. Near Algiers are the gardens of Madame Rossier, about 10 acres of which are devoted to cultivation of flowers for the local market. At Boufarik, Madame Rossier has also about 18 acres of nurseries of fruit and fruit trees. At the same place

are the beautiful nurseries of Mons. Herran, whose orangeries are models of cultivation; the trees are planted in lines at a distance of from 16 to 20 feet apart. Irrigation takes place twice a month after the roots of the trees have been bared. Broad trenches are cut, and at a suitable time they are smoked and then recovered after the irrigation. The cuttings are arranged so as to allow a broad space for the air and the sun. Besides these orangeries, there are about 35 acres of vineyards, which produced in 1881, wine to the value of £1,000. Not far off, at Blidah, are the superb orangeries of Mons. François, jun., who sent this year to France four million oranges. There are at Blidah nearly 1,000 acres planted as orangeries, and producing about £30 the acre, while the expense of cultivation is only a seventh of that amount.

Little has been done to assist nature in the cultivation of flowers in Algeria by man. Although the winters are mild, hothouses are necessary for propagating and for protecting certain plants from the heavy winter rains, or from the summer dust. At Algiers, in the flower market, there were to be seen some cut flowers, but few or none in pots. The flowers to be seen in April were our common ones, roses, geraniums, violets, heliotropes, lilies, heartsease, and pinks. If flowers are little cultivated in Algeria for private houses, they form a considerable industry for perfumery. Thirty years ago, Mons. Simonnet, at Algiers, and Mons. Mercurin, at Chéregas, introduced into the country the planting and distillation of odoriferous plants, since which time this industry has prospered so much, that the geranium alone covers more than 1,300 acres, and furnishes more than 6,000 kilogrammes of essence. The olive, suitably grafted and cultivated, will constitute an immense fortune for the country if it is worked according to its nature; it is thought that the region suitable for it could easily furnish 700 to 800 millions of square feet, producing annually more than 300 millions of francs.

In conclusion, a few words may be mentioned about the most precious plant for Algeria, the vine, which alone is destined to renew the face of the colony. It is planted everywhere from Kabylie (which produces an abundance of table grapes) to Morocco. And this is easily explained when we remember that at the end of five years the cost of the ground, the planting, and expenses of cultivation, is repaid, in addition to a revenue of £20 to £30 the acre. The vines are planted in lines from 5 to 6½ feet apart, to facilitate labour, and a road for carts is left around the plantations. Fortunately no phylloxera has yet appeared, but the curse of the vine in Algeria is the blue fly, which has to be knocked off the vines, and burnt with lime or petroleum. The expense of carriage is the great drawback to the prosperity of Algeria, and if this were lessened, it might become one of the richest colonies in the world.

CORRESPONDENCE.

SCREW PROPELLER.

Your remarks are well-timed, for the absurd pretensions put forward in respect to Frederic Sauvage have been allowed to fall without challenge in journals of authority. In supporting your statements, I may say that, besides the proposals of Trevethick, that ingenious mechanic, Samuel Brown, the inventor of the gas-engine, told me that he put a screw to a launch worked by a gas-engine about 1826 or 1827, so far as I remember. That launch he ran successfully on the Thames, and a small company was formed. She lay off Somerset-house. It came to an untimely end in connection with other embarrassments of Brown. After that Brown was abroad for many years.

Hyde Clarke.

32, St. George's-square, S.W., 1st Oct., 1881.

GENERAL NOTES.

Hughes's Induction Balance.—The following account of a trial of this balance is given by the *Times* correspondent at the Paris Electrical Exhibition:—"Mr. Elisha Gray, of America, whose name is so well known in connection with the telephone and the harmonic telegraph, was a disbeliever in the utility of the induction balance as a surgical appliance. He said to Professor Hughes, 'Thirty years ago, when working at some metal-work, a filing of iron entered my finger; the more I tried to extract it the deeper it went in. I believe it is still there; and if your instrument is of any value, you ought to be able to tell me in which finger it is.' The presence of bone or flesh in the coil of the balance would produce no effect; a metal or other conductor is necessary. Professor Hughes tested Mr. Gray's fingers; none of them gave any sound until he came to the forefinger of the right hand, when the balance of the coils was quite destroyed, and a noise was given out. This was the very finger in which the filing was buried 30 years ago. I need hardly say that Mr. Gray was completely convinced."

Iron and Steel Institute.—The annual meeting of this institute will be held this year in London, on Tuesday next, October 11th, and following days. The following is the list of papers to be read:—"The Manufacture of Steel and Steel Rails in the United States," by Captain W. R. Jones (Pittsburg, Pa.); "A Method of Securing Homogeneity in the Bessemer Process," by Mr. W. D. Allen; "The Manufacture of Ordnance at Woolwich," by Colonel Maitland; "The Application of Wrought Iron and Steel to the Manufacture of Gun Carriages," by Mr. H. Butter; The Manufacture of Projectiles," by Mr. J. Davidson; "The Distribution of Elements in Steel Ingots," by Mr. G. J. Snelus; "The Use of Brown Coal in the Blast Furnace," by Professor P. Ritter von Tünner (Leoben, Austria); "Certain Physical Tests and Properties of Steel," by Mr. Edward Richards; "The Tin Plate Manufacture," by Mr. Trubshaw; "The Use of American Anthracite in the Blast Furnace," by Mr. J. Hartman (Philadelphia); "Cavities in Cast Steel Ingots," by Mr. F. Stubbs; "The Recent Progress of the Basic Bessemer Process," by Herr Paul Kupelweiser (Director of the Witkowitz Works in Austria). A number of excursions to works in and near London have been arranged for the different days of the meeting.

Crystal Palace International Electric Exhibition.—The following announcement has appeared in the newspapers:—The second of the series of international exhibitions at the Crystal Palace inaugurated this summer by his Royal Highness the Duke of Connaught will be an electric exhibition. It is intended that this exhibition should be opened in December, and remain open some months. Nearly all the systems of electric lighting will be represented at the Crystal Palace, so that manufacturers, theatrical managers, and others, who are thinking of applying electric lighting to their factories, warehouses, theatres, &c., will, for the first time in England, have an opportunity of comparing the various electric lights and judging for themselves which will suit their local circumstances best. The winter is the best time for an electric exhibition, as the season will allow of the lights being seen from 4 p.m., or even earlier. In addition to the many and various systems of electric lights, Mr. Edison will have a complete exhibit of his numerous inventions. Telephones in their various forms will be strongly represented. Faure's and De Meriten's secondary batteries, Trouvé's boats, and many other scientific exhibits will be seen; and the managers hope to make this exhibition the most interesting to the public, and the most important, in a scientific point of view, of its kind, that has ever taken place in England. An honorary council of scientific and influential gentlemen is now being formed to advise and assist the directors in their undertaking.

Mineral Wealth of Turkey.—Admiral the Hon. Arthur Cochrane, in a letter to the *Times*, calls attention to the article in the last number of this *Journal*, on the mineral resources of Turkey, and suggests that "the bondholders should be advised to ask the Turkish Government for some substantial grants of land ascertained to contain metals and minerals."

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

"OWEN JONES" PRIZES, 1881.

This competition was instituted in 1878, by the Council of the Society of Arts, as trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of the subscriptions to that fund, upon trust to expend the interest thereof in prizes to "Students of the Schools of Art who, in annual competition, produce the best designs for Household Furniture, Carpets, Wall-papers, and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones." The prizes are awarded on the results of the annual competition of the Science and Art Department.

Six prizes were offered for competition in the present year, each prize consisting of a bound copy of Owen Jones's "Principles of Design" and a Bronze Medal.

The following is a list of the successful candidates :—

1. Gideon Fidler, School of Art, Salisbury—Design for carpet.
2. John Lamb, School of Art, Kidderminster—Design for carpet.
3. Thomas Dutton, School of Art, Nottingham—Design for lace.
4. Rose Phillips, School of Art, Northampton—Design for wall paper.
5. Robert Harris, School of Art, Salisbury—Design for chintz.
6. W. J. Clulow, School of Art, Macclesfield.

CANTOR LECTURES.

COLOUR BLINDNESS.

By R. Brudenell Carter, F.R.C.S.

LECTURE II.—DELIVERED MONDAY, MAY 23, 1881.

Mistakes of the colour-blind in daily life. Their methods of endeavouring to counteract the consequences of their defect. Modes of testing for colour blindness. Sources of error in testing. The actual prevalence of the affection in this and other countries, and in different classes of the population.

I endeavoured, in my former lecture, to explain as much as is known of the essential nature of colour-blindness; and I proceed to-day to describe some of the consequences of the defect. I may, perhaps, first be permitted to recapitulate that what we call colour is dependent upon the varying proportions in which different substances destroy the whiteness of the solar light, by subtracting from it some of the elements of which it is composed; that the colours of all natural objects are mixtures, because there is no object which subtracts, either from white or from previously coloured light, the whole of the red, the green, or the violet which it contains; and that the essence of complete colour-blindness is an incapacity on the part of the nerves of vision to respond to the stimulus which one of these three kinds of light is calculated to produce. There is nothing more difficult, even if it be in any way possible, than to realise to ourselves, or to make plain to others by verbal definitions, the nature of sensations of which we have no experience; and hence the precise appearance of the world to the colour-blind, and the difference between their sensations and those of the colour-seeing, must to some extent remain a matter of conjecture. For the purpose of illustration, however, and in order, in the words of old South, to employ those arts by which reason is wont to supply the deficiency of the reports of sense, we may assume what is not quite the case, namely, that white light is composed of red, green, and violet in equal proportions, and that the three colours are of equal luminosity. It would seem to follow, then, that to eyes which are incapable of seeing one of the colours, one-third of the total illumination of natural objects must be extinguished; and hence that the world, to the senses of the colour-blind, must be one-third less bright — one-third less luminous—than it appears to others. It follows, also, that the sensation which we call whiteness must be unknown to the colour-blind. Whiteness is the result of the combination of all three primaries, of which the colour-blind can combine but two. We have here an excellent illustration of the errors which are introduced into the question as soon as we begin to mix up facts with nomenclature. A child, who is, say, red-blind, sees white objects, is told by his elders that they are white, takes his idea of whiteness from their appearance, and would describe them as white to others. Their appearance to him, however, is the same that would be produced to the eyes of the colour-sighted, by an admixture of equal parts of green and violet; and the effect of such an admixture would be the same to him as whiteness, and forms the nearest approach to whiteness that he is capable of seeing or imagining. In the same way, the white of the green-blind is an admixture of red and violet; and the same principle applies to every other colour which may be presented to him. In other words, the colour-blind person loses, out of every mixture, the effect which is produced upon normal eyes by the presence of the element of red, or green, or violet, as the case may be, which that mixture contains, and sees only the remaining elements. That which is invisible to him is practically non-existent for him; and hence, if we have the elements of green and violet in a colour, and no others, the red-blind and the normal sighted would derive the same sensation from them. If we then add the red, the red-blind person would perceive no difference; while, to the colour-sighted, the colour of the mixture would be entirely altered. The former, the red-blind that is, would have no

means of being sure at any time whether the colour at which he was looking was composed only of green and violet, or of these colours with the addition of red. The nearest approach which we can make to a discovery of the mode of vision of the colour-blind, is by ascertaining how such and such mixtures would look to ourselves, if one of the primaries were blotted out from them, leaving the others intact. For this purpose, we have here a vertical wheel, capable of being made to rotate rapidly around a horizontal axis; and on this wheel we have three cleft discs of card, of the three primary colours, so contrived that we can expose more or less of any one of them. We will illuminate the surface by the electric light; and, with the three colours exposed in approximately correct proportions, will set the wheel into rotation. You no longer see a broad sector of red, a broad sector of green, and a broad sector of violet, but simply a white surface. We will now abolish the red sector, filling the whole circle with green and violet, and then the rotation of the wheel will produce a mixture of those two colours, which most of us would describe as a sort of bluish grey, and which must nearly correspond with the appearance which white surfaces present to the red-blind. In like manner, we will next remove the green, leaving only red and violet, and the violet, leaving only red and green; and in each case the rotation of the wheel will produce some resemblance to the appearance presented by a white surface to the green-blind or to the violet-blind.

It seems probable that, before long, improved means of examining the conditions of colour-blind vision may be furnished to us by the discovery of persons who are colour-blind with one eye only, and who will be able to compare, under proper direction, the impressions derived from the colour-blind eye with those derived from that which is colour-sighted. Two such persons have been recently made the subject of experiment by Professor Holmgren, and no doubt others will be found when looked for, as they will be now that attention has been directed to the fact that they may exist.

Professor Holmgren's two cases were one of one-sided violet-blindness and one of one-sided red-blindness; and he thus describes the results which he has so far obtained from them.

First, the diagnosis of both eyes was carefully made. In both cases there was found a perfect, typical, partial colour-blindness of one of the eyes, the violet-blind on the left, and the red-blind on the right eye; the other eye in each had a weak colour sense, but still was so nearly normal that the principal colours were ascertained with perfect ease. A slight hesitation was shown only in distinguishing the lightest and the darkest shades of those colours; and both the cases were therefore perfectly fit for the purposes of investigation.

The principle of the trial was exactly this: to let the normal eye control the perception of the abnormal one, and bring the result into a form that was perfectly plain to other normal-sighted persons. A one-sided colour-blind person has, through his normal eye, a perfectly clear conception of the normal-eyed people's different colours, and is able to explain the conception of these colours which he obtains through his abnormal eye. His definitions are thus in opposition to those of persons colour-blind on both eyes, perfectly trustworthy. As words are always less trustworthy than actions, and an attempt at description is inferior to a shown colour, Holmgren has in every instance let the person in question point out an objective colour with his normal eye to correspond with every one of his conceptions with his abnormal one. Indirectly, we find out in this way which qualities of perception are wanting in the abnormal eye in comparison with the normal one. The same result is arrived at by letting the colour-blind eye control the subjective perception of the normal.

As has been long supposed for good reasons, a colour-blind person sees only two colours in the spectrum. These are his two subjective principal colours.

The principal colours in the spectrum of a violet-blind person are, as to their fundamental tone, red and green. Towards the red end his spectrum has quite the same extension as that of a normal-eyed person, and is thus, in comparison with the latter, "unshortened." Reckoned from the red end, his first fundamental colour stretches over that part of the spectrum which is generally seen as red, orange, and yellow. First in the yellowish-green, a little on the other side of Fraunhofer's line D, he sees a narrow uncoloured "paper-white" belt, from which his other colour, green, commences, and is continued with at first more and more saturated, and afterwards darker and darker shades, over the place where we see green, greenish-blue, cyan-blue, and indigo, to the commencement of the violet, where his spectrum absolutely ends with a sharp limit, about Fraunhofer's line G. His spectrum is thus at this end considerably shortened. The fact that violet-blind persons confuse the pigment colours, such as green and blue, purple and red, orange and yellow, violet and yellowish green and grey, is thus explained of itself. Respecting the tone of the violet-blind person's subjective fundamental colours, it may be said that his red is not quite identical with the common red of the spectrum of the normal-eyed, which is something like cinnabar, but is rather a clearer red, having a shade of carmine, about the same as the red towards the end of the subjective spectrum of the normal-eyed. His other fundamental colour, green, is also a clear green that for the normal eye has a shade of blue in it.

The two principal colours in the spectrum for the red-blind are, as to their fundamental tone, yellow and blue. The yellow commences a little later, reckoned from the end, than the red of the normal-eyed, about Fraunhofer's line C, and stretches over the rest of the red, orange, yellow, yellowish green, and ends in the blue-green, between Fraunhofer's B lines and F, nearer to the latter, where a narrow neutral colourless belt forms the limit against the other principal colour, blue, which stretches through the remaining part of the spectrum, corresponding with our cyan-blue, indigo, and violet. At this end there is no shortening. The red-blind person's confusing of pigment colours, green and yellow, orange and red, purple and blue and violet, red and blue-green and grey, is equally well explained by this.

All this, as we see, writes Professor Holmgren, is in perfect accordance, objectively taken, with

the Young-Helmholtz theory. Regarded from a subjective point of view, we should perhaps have expected green instead of yellow as one of the fundamental colours. But that yellow, and not green, is that colour, as I have already for some time supposed, does not shake the basis of that theory, as has been shown by Fick and by myself. Besides, the tone of the red-blind person's first fundamental colour is not perfectly golden yellow, but seems for the normal eye to have a shade of greenish-yellow, perhaps best defined as citron-yellow in the lighter, and as olive-green in the darker shades. His other fundamental colour does not seem to be purely cyan-blue or indigo, but it is rather a blue with a perceptible shade of violet. It might be called indigo-violet. Perfect clearness in the theory will not perhaps be gained until we have had opportunity of studying more cases of different kinds and degrees, and especially a case of typical perfect green-blindness. Professor Holmgren adds that he is preparing a large work upon the subject, and the foregoing observations point to the possibility that our present conception of red, green, and violet as the primaries may yet be found to require some modification.

If we turn now to the actual mistakes made by the colour-blind in daily life, as consequences of their defect, we shall find these to be less numerous and less remarkable than might have been supposed; insomuch that nothing has come as a greater surprise to many persons than the recently acquired knowledge of the great prevalence of the condition. Dalton, the chemist, was totally red-blind; and when we hear that he said that the bright upper side of a laurel leaf was to him a perfect match for red sealing-wax, while the back of the leaf was an equally good match for the darker colour of a red wafer, we are at first sight inclined to think it impossible that such a state could escape recognition, even for a single day. He compared the colour of a florid complexion to a film of diluted ink spread over white paper; and said that blood was not unlike the colour which he heard called bottle-green. Although a member of the Society of Friends, he wore in the street, with perfect complacency, the bright scarlet gown of a Doctor of Civil Laws; and said, when asked by Whewell what it resembled, that it was of the same colour as the leaves of some evergreens outside the window, and that the lining, which was of pink silk, was undistinguishable from sky-blue. It would be tedious to enumerate errors of the same class which have been recorded of different colour-blind persons by various observers, and which depend, usually speaking, upon some unexpected test being applied to them in an unusual manner. I am acquainted with a family in which the father sent one of the sons, then a boy of nine or ten years old, into the next room to fetch him a book, which he described as of a green colour. The boy brought back a book like this (a red one), and his mistake led to an investigation, which disclosed that he and all his brothers were red-blind. In a general way, however, the colour-blind manage to avoid mistakes, because they soon learn to supplement their defective sense by the study of other peculiarities of objects. Among children bred in the country, the first thing which teaches a colour-blind to feel or suspect a difference between himself and other people is, usually, the difficulty which he experiences in seeing any difference between ripe fruit or red berries and the leaves which surround them. Even here, it must be remembered, he sees *a* difference, although not *the* difference; because the colour to which he is blind presents to him a surface which is deficient in luminosity when compared with others, although he conceives it to be identical in colour. Thus, to quote an illustration from Dr. Joy Jeffries, a child hears people speak of the flowers or buds of the corn poppy as red, and of the leaves and stems as green. He does not perceive any ground for this broad distinction; but, seeing that it is made by those around him, and that he is laughed at if he is mistaken with regard to it, he sets himself to work to study carefully the appearances of the flowers and of the leaves respectively, and to fix in his memory slight differences, such as an eye capable of perceiving the great difference might easily overlook, and which will, nevertheless, represent to him the former. Thus, he notices slight differences in apparent luminosity of surface, and interprets these as being the same things which others call differences of colour. Unless he happens to be accidentally tested, like the boy of whom I have spoken, with nearly pure red or green, he may not only for a long time escape the detection of other people, but he may even remain unconscious of his own defect. It must be remembered that he sees certain things, and hears them described as red; and that the appearance which they present to him will give him his notion of what it is that other persons mean when they call things red. He may only be detected when some casual event serves to render useless all the fine distinctions which he has acquired; as when the gentleman who was travelling wrote a letter to his family, commencing and completing it at different halting-places, half of it in red ink and half in black, without being himself conscious of the difference. On this part of the subject some very pertinent remarks have been made by Dr. W. Pole, F.R.S., who is himself red-blind, and also by Professor Holmgren. Mr. Pole says:—

"The colour-blind must be very liable to associate, almost indissolubly, the true normal name of a colour with the sensation it conveys to their minds, whatever that sensation may be; and they may, therefore, be easily led to speak of that colour as if they saw it like other people, although the sensation they refer to may be really of quite a different nature to that which the name implies. A colour-blind person will be especially loth to believe that certain colours, which he hears about and talks about every hour of the day, can be invisible to him. Objects of these hues will probably present to his mind some ideas of colour, though not the true ones, and he may naturally imagine, therefore, that he does see them, and may give his description accordingly. And this sort of error is very much enhanced by the fact that it is not an easy matter to refer different tones of any one colour to the same colour sensation; so that a modification of tone, if considerable, may be easily supposed to be a different colour. I believe this difficulty is also felt by the normal-eyed; and the popular nomenclature of colours furnishes illustrations of the fact, different tones of the same colour having often different names, and being treated as separate colours. Pink and crimson, lilac and violet, are well acknowledged examples of this; and a dark shade of orange is called brown, which generally passes for a separate colour. Hence we may easily see what a great probability there is that the colour-blind may acquire the

habit of attaching the names of different colours to what are, in reality, only varieties of the same sensation; and as this habit dates from their infancy, and is encouraged by their every-day communication with the world, it is much more difficult to get rid of than might be supposed. The sufferer may find himself continually blundering, but he must go through a very rigid self-examination before he can trace this to the fact that some of the principal ideas he has all his life held upon colour are mere delusions. Taking red as an example, it is the highest degree natural that persons who are continually seeing this colour under the appearance of dark yellow, should imagine that the latter sensation, which is certainly very distinct from that of full yellow, is what corresponds to the term red; and the notion that they cannot really see red at all, is one they have the greatest difficulty in comprehending. Hence the very general assertion by the colour-blind that they do see red, an assertion which I think has been far more readily accepted than it ought to be. Red is a more common colour than dark yellow, and hence the preference, by the colour-blind, of the former name for the common sensation. A great variety of bodies are known to be red by habit and association, and are for this reason often named correctly. My own experience is very decided on this point. It is only after long and careful investigation I have come to the conclusion that my sensations of colour are limited to blue and yellow. But, before I found this out, that is, for nearly thirty years of my life, I firmly believed that what I now know to be only differences in tone of one or the other of these were different colours; and hence I was in the habit of talking of red, crimson, scarlet, green, brown, purple, pink, orange, &c., not, of course, with the confidence of the normal-eyed, but still with a full belief that I saw them. If, therefore, at that time, any scientific man had examined me, I should have given him a description of my case, which I now, after more careful study, know would have been utterly wrong. I should have told him, among other incorrect statements, that I saw red objects of a full tone, such as vermilion, soldier's coats, &c., perfectly well; and I could, if necessary, have supported my assertion by naming correctly a great variety of bodies having this colour, which, indeed, I am in the habit of doing every day. It would have been inferred, with great appearance of truth, that I was really impressable with the red sensation; but I now see what an erroneous inference this would have been."

Another source of confusion in interpreting the descriptions of the colour-blind is the want of due appreciation of the different sensations that may be produced on their minds by modified hues of the same general colour. The normal-eyed person considers green, for example, as always green, whether it be yellow-green, blue green, or neutral green; whatever the particular "shade of green," as it is called, it still has, in his eye, the distinguishing character of greenness, which cannot be hidden or disguised by any predominance of blue or yellow which it may contain. But with the colour-blind this identifying characteristic of greenness is wanting; and hence several persons speaking of green may, by each having reference in his own mind to some particular hue of the colour, describe it in the most contradictory terms. One may say, with perfect sincerity, that green appears to him like red; another, that it looks yellow; a third, blue; a fourth, black; a fifth, orange; a sixth, violet; from which the normal-eyed examiner, impressed with the unity of greenness, may naturally infer that each person is suffering under a different species of the disorder; while, by proper interpretations, these anomalous descriptions would only convey the expression of one consistent truth, and one perfectly uniform defect of vision.

It will, I think, help us to understand the peculiarities of vision in question, if we endeavour to free our minds entirely from the influence of the phrase "colour-blind," and if we think of the subjects of the defect as of persons who are not "colour-blind" at all, but who are red-blind, green-blind, or violet-blind. The only really "colour-blind" people are those who are blind to all colours, while they still see light and shade and form; and of these a very small number of authentic instances have been recorded. The others, those who are red-blind, or green-blind, or violet-blind, in the words of Holmgren, perceive, in the main, the same kind of light as the normal observer, but they perceive part of it in another manner. In the system according to which they arrange their colours, they have fewer kinds than the normal observer; and this is why they are obliged to classify under the same denomination a portion of the colours classed by the normal observer under different heads. It results from this that they find resemblances between colours, or confuse others, which to the normal observer are quite different; for instance, red and green. These confusions naturally surprise and amuse the normal observer, who readily imagines that they arise from very great ignorance of colours, or from defective training. He ordinarily supposes that there is no limit to the mistakes the colour-blind might make in this respect. But this is not the case; for each variety of colour-blindness obeys laws quite as exact as those which govern the impressions of the normal observer. A colour-blind person can no more accustom himself to seeing colours as the normal observer does, than the red-blind can see colours in the same way that the green-blind does, or *vice versa*.

This view of the matter, which is based upon experience, explains to us how the colour-blind see colours; but, if we only rest our ideas upon the names given to colours by the colour-blind, we can be easily deceived. To judge correctly of colour-blindness, and of the various practical questions connected with it, it is of the highest importance distinctly to observe the difference between the manner in which the colour-blind person *sees* colours, and the manner in which he *names* them. The sensation is based upon the nature of the sense of colour in the organisation of the optic nerve from birth. The *name*, on the contrary, is learned. It is conventional, it depends upon exercise and habit. The names of colours are naturally the expressions of sensations; but, on the other hand, they are regulated by the system of normal sight, and cannot, consequently, agree with that of the colour-blind. They can, nevertheless, be learned by the latter, and even applied correctly in many cases. It is the want of a clear understanding upon this point which has given rise to the most serious embarrassments and errors. The normal use of colour names has been and still is one of the chief causes of our erroneous ideas on the subject of colour-blindness existing in the masses, because such use is the veil under which the defect usually conceals itself from our observation in every day life, and under which, even to the last moment, it will succeed in escaping

discovery in cases where, as frequently happens, the methods of exploration employed are indecisive, or are based upon erroneous principles.

When we first think of the condition of the colour-blind, it is difficult to understand how they can fail to be immediately detected when in the company of men endowed with normal sight; but daily experience shows us that they do escape. In testing the persons employed upon a railway, for example, who are required night and day to give attention to coloured signals, we usually find that a number of colour-blind are discovered, although their defective sense had not previously been suspected either by themselves or others, and the majority had correctly performed their duties. But, as I shall hereafter have to show, the fact of having avoided mistakes for some given period does not afford to the colour-blind signalman the slightest security for the future. His defect will some day surely find him out, and that at the very time when he is least suspicious of its influence. As a matter of fact, it is found that the number of colour-blind persons employed on the American railways has been diminished by the occurrence of mistakes on their parts which have been attributed to carelessness, or even to drunkenness, and which have led to their being discharged, not as colour-blind, but as bad servants. A recent American writer says that the colour-blind eliminate themselves from railway employment in this way in the course of a few years, and that they are never found among the old servants of any company. Unfortunately, in the process of eliminating themselves, they have often eliminated other people also.

The methods for testing for colour-blindness must be adapted, it is evident, to avoid the sources of error which Messrs. Pole and Holmgren have pointed out as likely to arise from nomenclature, to avoid those also which might arise from the different luminosity of the various tests, and to be rapidly applicable in practice to large numbers of people. All these conditions are fulfilled by Professor Holmgren's coloured worsteds, and by these only; although there are many other methods of examination which are applicable for different purposes, and especially for analysing the precise nature and degree of colour-blindness in cases in which it has been already discovered to exist.

The worst conceivable test, that which on the one hand would allow a large proportion of the colour-blind to escape detection, and which, on the other, would cause persons to be set down as colour-blind who were not so in reality, is one which has been adopted, in pure ignorance, by certain railway companies, who profess to test the colour-vision of those seeking employment on their lines. This test, the worst feature of which is perhaps its superficial appearance of being satisfactory and complete, consists in the exhibition of red and green lights, alternately or in irregular succession, while the candidate is called upon to name them as they appear. In order to estimate this process at its true value, it must be remembered, that a red and a green light, under similar conditions of illumination, would not look alike to a colour-blind observer, who, if he were red-blind, would see the green light as the more luminous of the two; and, if he were green-blind, would see the red light as the more luminous of the two. Between the two lights, therefore, there would in either case be a distinctive difference of their apparent luminosity; and the person examined would manifestly have more than an even chance of being right in his guess as to which of the two was red and which was green; and would be able, if he were right the first time, to keep right all through the questioning process. An examiner who knew or suspected that the candidate was colour-blind, might be able to lead him into error if he had command of a contrivance by means of which the brightness of each lamp flame, behind the coloured glass, could be increased or diminished; but nothing of this kind has been ordinarily employed for the purpose, and it would at best be a troublesome contrivance. A man who was not colour-blind at all, but only dull, or careless, or imperfectly acquainted with the names of colours, although quite able to distinguish them, might easily call red green, or *vice versa*; and then the question would arise as to how many mistakes in the name of the exposed colour might be accepted as evidence of colour-blindness, or how many correct answers as evidence of colour vision. When thus regarded, it is manifest that the test is worthless; inasmuch as no colour-blind person would be likely to be wrong every time, and many colour-seeing people, of the class from which railway servants are chiefly taken, would be very likely to be wrong occasionally. Besides these objections, there is the further one that no test is satisfactory which rests in the least degree upon nomenclature. The object of the examination is to discover whether some given person sees colour in the same way as the majority of mankind, or in the same way as the colour-blind minority; and what the colours are called, either by the majority or by the minority, has nothing whatever to do with the real question at issue.

Now the principle of Holmgren's method of examination is to compel the colour-blind to reveal themselves by their acts, altogether without reference to their language; and for this purpose they are not asked the names of colours, but are directed, from among a large number of coloured objects, to select the tints which match or resemble certain selected patterns which are placed before them. If the persons examined are colour-sighted, they will select only the correct matches for this purpose, while, if they are colour-blind, they will make certain definite mistakes which will disclose the precise nature as well as the existence of their defect, and which could be predicted by any who were previously aware of it. A person who was only careless, or a person who, if such a thing could be conceived, was simulating colour-blindness from mischief or from some other motive, but without adequate knowledge, would, so to speak, make the wrong mistakes, and would thus betray himself at once to a competent examiner.

For the purposes of such an examination, almost any coloured substances might be employed; but skeins of Berlin wool are found to present many practical advantages. They are cheap, easily handled, easily obtainable in every variety of tint, and therefore easily replaced when soiled or injured. Holmgren's full collection consists of about one hundred and fifty skeins, including red, orange,

yellow, yellow green, pure green, blue green, blue, violet, purple, pink, brown, and grey; several shades of each colour, and at least five gradations of tint, from the deepest to the lightest. Green and grey, several kinds each of pink, blue, and violet, and the pale grey shades of brown, yellow, red, and pink, must be especially well represented. The normal-eyed readily selects the right ones from the mass; whilst the colour-blind, although the right ones are directly before him, picks out the wrong ones, and thereby at once discloses the character of his defect.

Arrangements have been made, by some observers, for presenting colours already sorted to the persons under examination; and I have here a piece of worsted work, arranged by Dr. Dane, in which, on some of the lines, the colours which are liable to be confounded are placed in juxta-position. The objection to all schemes of this kind is that the colour-blind have to be asked questions about a sorting which has been already performed by others; while, in the Holmgren method, they reveal themselves with much greater rapidity and certainty when engaged in accomplishing the sorting for themselves.

The time at my disposal does not allow me to repeat the reasons, partly theoretical and partly derived from experience, which have guided Professor Holmgren in the selection of his sample colours; and it is sufficient to say that these are light green, purple, and bright red.

In conducting the examination, the worsteds are placed on a large table, in broad daylight, and on a white cloth. A skein of the test colour is picked out by the examiner, and is laid down at a short distance from the pile. The person examined is then directed to select from the pile the other skeins which resemble the sample in colour, and to place them by the side of the sample. The examiner should first do this himself, and then mix the skeins again, so as to show the examined exactly what is required from him; and, when a large number are to be examined, the instruction should be communicated to all at once, and then each should step forward singly and in turn to make his or her selection. In this way about a minute will suffice for each individual.

The colours which are exhibited on the screen before you, and which are taken from Holmgren's work, are intended to show the nature of the mistakes which exhibit colour-blindness. The plate does not exhaust these mistakes, and shows only those which are most characteristic. The test colours are arranged horizontally; while the colours of confusion, or those which the colour-blind are liable to confound with the former, are arranged vertically beneath them.

In the first place, the green sample is presented to the examined; and the examination must continue until he has placed near to it all the other skeins of the same shade, or else, with these or separately, one or several skeins of the class corresponding to the colours of confusion, the drabs, fawn colours, or light yellowish browns; until he has sufficiently proved by his manner of selection that he can easily and unerringly distinguish between the mixed-up colours, or until he has given proof of unmistakable difficulty in accomplishing the task. He who places beside the sample one of the colours of confusion, who finds, that is, that one of them resembles the sample in colour, is colour-blind. He who, without being quite guilty of this confusion, yet evinces a manifest tendency towards it, has a *feeble chromatic sense.* If all we need is to determine whether a person is colour-blind or not, no further test will be necessary. If we want to know the kind and degree of colour-blindness, then we must go on to another test.

For this purpose, the second or purple sample is set aside from the pile. Its colour should be intermediate between the lightest and the darkest specimens of its class; and it must be remembered that purple consists of two colours, red or orange, or violet or blue, which are never confounded together. The examination must be continued with this second sample until the person examined has placed near to it all or the greater part of the skeins of the same shade, or else, simultaneously or separately, one or several skeins of confusion. He who confuses the colours will select either the light or deep shades of blue and violet, especially the deep; or the light or deep shades of one kind of green or grey inclining to blue: or shades of purple, red, and orange, indiscriminately.

He who is colour-blind by the first test, and who, in the second, selects only purple skeins, is *incompletely* colour-blind.

He who, in the second test, selects with purple only blue and violet, or one of them, is *completely red-blind.*

He who, in the second test, selects with purple only green and grey, or one of them, is *completely green-blind.*

He who, in the second test, mingles red or orange with the purple, is *completely violet-blind.*

The red-blind never select the colours taken by the green-blind, or *vice versâ*; and thus we obtain, in a simple manner, evidence of the distinctness of the two defects.

With this second test, the examination may be concluded; and it is not even necessary, practically, to decide whether the blindness is to red or to green. But to be more completely convinced of the relation of colour-blindness to the signal colours, and especially in order to convince, if necessary, railway authorities and others who are not experts, the examination may be completed by one more trial, which should be used only with the completely colour-blind, and which is not necessary to the diagnosis, but which still serves to corroborate the results of the preceding investigation. For this purpose, a vivid red skein is set aside, one of a red rather inclining towards yellowish, and resembling the red used for signals. The examination should then be continued until the subject has selected all the skeins belonging to this shade or the greater part of them, or else separately, one or more of the colours of confusion. The red-blind will choose, besides the red, green and brown shades which, to the normal sense, seem darker than red. The green-blind will choose opposite shades, which to the normal-eyed appear lighter than red.

As far as regards railway and marine signalling, the state of complete red-blindness or of complete green-blindness should be regarded as an absolute disqualification; while the existence of complete violet-blindness, which involves no liability to confusion between red and green, may be entirely dis-

regarded. A practical difficulty will sometimes arise in the case of incomplete red or green-blindness; and the examiner may be asked whether a given person is red-blind or green-blind enough to be a source of danger to himself or others. We have here to deal with a question of degree only; and all which the expert can do is to reduce the degrees of incomplete colour-blindness to numerical standards. When this has been done, it will be for the authorities to draw the line of safety.

For this purpose, it must be assumed that a normal-eyed person will distinguish the colour of a given object at some stated distance; and it follows that the incompletely colour-blind, who can only arrive at the same distinction by means of a stronger impression upon their nerves of sight, must approach nearer before they can speak with the same certainty. Hence, the distance of colour vision in the normal-eyed being taken as a standard. the smaller distance of colour vision in the incompletely colour-blind affords at once a numerical measure of their defect. If the normal-eyed can distinguish between red and green at ten feet, and the incompletely red-blind only at five feet, with test objects of the same magnitude, and with light of the same intensity, the latter may be said to possess one-half of the normal acuteness of colour vision. In order to determine the point, Holmgren employs an apparatus so contrived as to cast coloured shadows, the intensity of which can be regulated at will; but perhaps the best contrivance for the purpose is that of Professor Donders, or an ingenious modification of it by Mr. Nettleship. I have here Donders's lantern, which carries a pair of revolving discs, so arranged as to display, to a person under examination, a circle of either red, white, or green light of larger or smaller sizes; and it is found in practice that, whereas the normal-eyed distinguish colour as soon, or nearly as soon as they can distinguish the light, the incompletely colour-blind have to approach much nearer, or to be shown a much larger circle, before they can arrive at the same decision with any certainty. In Mr. Nettleship's lantern, two circles of different colours can be shown simultaneously and side by side, and with both of these contrivances a number of interesting trials may be made.

I have still to speak of the relative frequency of colour-blindness in this and other countries, and among different classes of the population; and on this point it is only quite lately, since Holmgren's method of examination has been understood and adopted, that any trustworthy statistics have been procurable.

The examinations of earlier times, under which various colours were held up, and the persons examined were desired to name them, must be dismissed as untrustworthy; and, of all those made in recent times, I should place most reliance upon the work of Professor Holmgren himself, and upon that of Dr. Joy Jeffries, in America. It must be remembered, that all examinations of small numbers are apt to be misleading as guides to statistics, because colour-blindness has a marked hereditary tendency, so that it constantly affects several members of the same family, who, if they should be collected in the same school, or within the same locality, may easily fall into the hands of a single examiner, and so vitiate the numerical value of his results when these are taken as tests of the amount of colour-blindness in the total population. Professor Holmgren examined 32,155 male persons, described as scholars and children of different ages, young people, railroad *employés*, sailors, soldiers, mill hands, prisoners, and guards, and among these he found 1,037 colour-blind, or a fraction more than 3·25 per cent. Dr. Jeffries examined in New England 10,387 teachers and scholars, and found 431 colour-blind, or 4,149 per cent. In other countries, excepting for occasional results, showing much greater numbers, and where some error has probably crept in, the results are practically much the same, and in all countries the per-centage of colour-blindness is very much smaller among females than among males. Thus, among 7,119 females of all ages, Holmgren found 19 colour-blind, or 0·26 per cent., and Jeffries, among 7,942 female teachers and scholars, found only 4 colour-blind, or 0·52 per cent.

Until the present year, nothing has been known of the actual prevalence of colour-blindness in England, although Wilson, who wrote in 1854, pointed out its frequency, and asserted that it was more frequent among the Society of Friends, and also among the Jewish community than in the general population of the country. In the course of last winter, the Ophthalmological Society of London appointed a committee to inquire into the prevalence of various defects of vision, among which colour-blindness occupied a prominent place; and that committee, of which I have the honour to be a member, made arrangements for testing the colour-vision of the Metropolitan Police, of some of the household troops, and of pupils at various schools. By the indefatigable industry of our honorary secretary, Dr. Brailey, seconded by a large number of gentlemen who gave up the requisite time to the work, no less than 18,088 persons were examined by Holmgren's method in the course of five months. Of these, 16,431 were males, and 1,657 were females. Certain classes of people were especially examined, in the expectation that they would furnish a larger proportion of colour-blinds than the general population. Omitting these classes, we have 14,846 males, with 4·76 per cent. of persons with colour defect, and 489 females, with 0·4 per cent., so that in this country the colour-blind females are only one-tenth the number of the colour-blind males. In fact, the rarity of colour-blindness among women renders them less indulgent towards it than they are towards any other distinctive male weakness; and one of the examiners told me that, in his experience, the first impulse of a mother, when she saw her son picking up a drab to go with a green, or a chocolate with a purple, was to box his ears. I have myself found the impossibility of keeping a mother quiet in such circumstances, and have been compelled to ask her to withdraw into another room until I had satisfied myself upon the point at issue.

The above-stated per centage of 4·67 includes the incompletely colour-blind as well as the complete cases, and the former alone would amount to something like 3·5 per cent. If we confine ourselves to these, and compare the results with those afforded by the selected classes, namely, the members of the Society of Friends, the Jewish community, and the inmates of deaf and dumb asylums, we find that complete colour blindness among the Friends

amounts to 4·9 per cent., among the Jews to 5·9 per cent., and among the deaf mutes to 13·7 per cent. In these selected classes, the subjects were all school children, and the Jewish children were drawn from a poorer class than the rest, a fact which may to some extent account for the larger numbers which they yielded. For while, in England, an examination of 4,932 men of the Metropolitan Police, and of 1,729 children of the same class, gave 3·7 per cent. of complete defect, 2,671 children in middle-class schools afforded only 3·5 per cent.; 435 medical students and sons of doctors afforded only 2·5 per cent., and 769 Eton boys afforded only 2·46 per cent. The examinations show clearly that the defect has no tendency to cure itself, or to be removed in the course of growth; for, among people of the same class, the percentage was the same in adults as in children. In the same way, among the classes which presented high per-centages, there were more female colour-blinds than among the general population, but the relative proportion of females to males underwent no increase, and the female cases were nearly all slight or incomplete. Among the whole number examined, three of total colour-blindness are said to have been discovered, and a few of violet blindness; but the latter were included among the partial cases and were not made the subjects of any special experiments. Upon the whole, therefore, it may be assumed that, among the classes from which railway drivers and naval look-out men are chiefly derived, a per-centage of more than four and and a half may be regarded as the normal proportion of the completely or incompletely colour-blind; and it will be my endeavour, in the next or concluding lecture of the course, to point out what this means in the way of preventible risk for travellers both by land and sea. There is only too much reason to believe that some of the worst traffic accidents which have happened, both on land and water, including among others the loss of the *Ville de Havre* passenger steamer, were directly due to the want of colour perception in those by whom the courses of one or both of the vessels which came into collision were controlled. On this point, however, I am somewhat anticipating what I shall have to say on the next occasion of my addressing you.

MISCELLANEOUS.

ELECTRIC LIGHTING FOR COAL MINES.*

By Andrew Jamieson.

In the discussion which followed the exhibition of Swan's lamp at the Society of Telegraph Engineers in October last, Professor Tyndall remarked that probably this form of incandescent lamp could be adapted for use in coal mines as a safety lamp. Since then, two practical trials have been made with this object in view—the one at Pleasley Colliery near Nottingham (June 15 and 18), the other at Earnock Colliery on August 9th and 11th. These instalments have created not only a scientific but also a commercial as well as a general and public interest.

The circumstances under which the lighting has to be produced and maintained are new, and different in many respects from that now being carried out above ground in our halls and open spaces. Dangers and difficulties peculiar to the situation have to be guarded against or overcome, such as explosive gases, subsiding of walls or seams, continuous darkness, &c. Long lengths of leading wire have to be dealt with, involving single or double offshoots here and there, requiring considerable mechanical skill and still more electrical knowledge before a suitable distribution of the electric current is effected, and the desired uniformity and intensity of light obtained.

Particular interest is at present being manifested by mine owners, managers, and engineers, to know the commercial value of the light, or in other words, whether the possible increased light and safety of Swan's lamps over the methods hitherto adopted will result in an economy and an increased output of coal for the same expense on labour.

Again, a general and public interest is always awakened in this country when anything is done, or even attempted to be done, for the benefit of our fellow creatures, and more especially when this attempt is directed in aid of our helpless brothers who toil from morning to night, and night to morning, in the ever dark and dismal bowels of the earth, in order to furnish us more fortunate beings with the means of supplying ourselves with coal for our comfort, power, and luxury.

In attempting, therefore, to place before you a few of the leading mechanical and electrical features of the case, I hope to be able to interest you for a few minutes, and to express a desire that the remarks elicited by the discussion may assist materially in promoting and perfecting electric lighting for coal mines.

In the first place, I shall review shortly what has been already done at the Pleasley and Earnock Collieries, with an account of the apparatus used, a few of the experiments carried out, and, finally, close my remarks with what appears to me the simplest, most economical, and best means for fitting up a colliery with Swan lamps.

Pleasley Colliery.—In June last, Messrs. R. E. Cromton and Co., in conjunction with Swan's Electric Light Company, laid down at Pleasley Colliery* a temporary arrangement of engine, boiler, dynamo machines, leads, lamps, &c., which they placed at the disposal of the Royal Commissioners for Mines in order to test the suitability of the Swan lamp, as a means for lighting up the shaft bottom, roadways, and working faces in coal mines.

The large drawing on the wall gives a general view of the complete system as carried out at Earnock Colliery, near Glasgow, by Messrs. D. and G. Graham, for Mr. Watson, the proprietor. The enlarged plan is from a scale drawing, kindly furnished to the author by Mr. Gilchrist, manager of the mine.

Earnock Colliery. — The engine and generator are placed about 260 yards from the pit-head. The engine is 12 N. horse-power, constructed by Messrs. Shanks, of Arbroath, having their sensitive governor (about one-third of this power being only required for the present installation). A counter shaft, driven directly by a leather belt from the fly-wheel of the engine, constitutes the intermediate means by which the speed is increased for driving an "A" Gramme dynamo generator. The two main leading wires from the dynamo machine, are led up through the roof, and fixed on two bare copper ropes respectively $\frac{3}{8}$ of an inch in diameter. These copper conductors are carried on poles to the pit head, and insulated at the supports by means of ordinary porcelain insulators and vulcanised india-rubber, and thereafter continued down the shaft to the pit-bottom, a further distance of 354 yards, by two leading wires, consisting of a copper

* The substance of a paper read before Section G of the British Association, York Meeting, September, 1881.

* See *Electrician*, vol. vii., No. 6, pp. 84 and 88

strand insulated with gutta-percha, taped and tarred, the whole being enclosed in a galvanised iron tube. The same description and size of main leading wire is used along the whole distance of the seam to two working faces, a complete distance of 750 yards from the pit-bottom, making the entire distance from the generator to the extreme lamp 1,564 yards, or say 3,128 yards of main leading wire. At each of the twenty-two positions shown in the figure is joined up by branch leads a Swan lamp, encased in a suitable lantern, sixteen of these being fixed lamps, and six portable. The lanterns containing Swan's lamps were described, they were made from the design of Messrs. D. and G. Graham. Each of the twenty-two lamps was provided with an air-tight gravity mercurial contact for the purpose of switching on and off the current. They were peculiar in this respect, that upon cutting a lamp out of circuit they bring into circuit a wire resistance equivalent to that of the lamp. The primary object of these air-tight makers or switches is to prevent the spark which is inevitably generated when opening an electric circuit from communicating with and exploding the gas in a fiery mine. Several forms of such air-tight makers have been designed by the author in order to prevent making a spark when joining up a lamp or lead.

The principle upon which the lamps were arranged was that of "parallel circuit." This system of joining up the lamps is neither the best nor the most economical that can be arranged. It necessitates their being of nearly uniform resistance, or of slightly decreasing resistance in proportion to their distance along the main leads, in order that the current may be uniformly distributed among the lamps, and thus give to each lamp the same illuminating power.

It may not be out of place here to mention that a good Swan lamp has a resistance when incandescent (at 20-candle power), of 30 ohms, with an E.M.F. or a difference of potential on its terminals of 45 volts, and, therefore, a current of 1·5 weber passing through it. This is slightly over 220 candles per h.p. absorbed by the lamp. The author has ascertained by actual tests carried out by himself in Glasgow, from a mean of several lamps tested, that:—

Res. in ohms (hot)	E. M. F. (volts)	Current (webers)	Candle power	Candles per h.-p.	H.-P. per lamp
25	43	1·7	18	175	·1

Of course it must be clearly borne in mind that the higher the candle-power at which the lamps are worked the greater the (horse-power) economy. If a Swan lamp were raised to a temperature sufficient to give 600 candles, then we should have about 1,200 candles per horse-power. On an average we may consider it a safe statement that ten Swan lamps absorb one-horse power. This does not take into consideration the fact that a certain amount of power is absorbed in the engine, generator, leads, &c., and in making an installation of say fifty Swan lamps we may reckon 30 per cent. at least of the power as lost in the manner indicated, which leaves seven lamps per indicated horse-power, or it will require seven indicated horse-power for fifty lamps, giving eighteen-candle power each.

It is important to note that the system adopted at Earnock Colliery is far from being the best for Swan's lamps, in as far as the self-exciting Gramme machine does not readily admit of any automatic current regulation. For example, if under ordinary circumstances we have twenty-two lamps in action, and it be desired suddenly to cut out any number of these, say ten or twelve, the immediate effect will be that of overstraining the remaining lamps by excessive currents. At Earnock Colliery, however, an attempt has been made to avoid this danger by causing any switch to introduce a resistance equivalent to that of the lamp which it cuts out. It will at once be seen that this is an uneconomical expedient, because the resistance thus introduced absorbs power equal to that previously absorbed by the lamp now cut out. If a Siemens's alternate current machine (with separate exciter for magnets) be used, then the E.M.F. remains practically constant whatever change is made in the number of lamps in circuit, and thus without any direct current regulator the lamps are never endangered.

This is a very great improvement upon the self-exciting Gramme or Siemens machine, and entirely does away with the necessity for a specially constructed system of automatic current regulator. It, therefore, simplifies the mechanical arrangements, and does away with the danger and inconveniences arising from turning off or putting on a number of lamps (within the limits of the machine).

These alternate current machines of Siemens also admit of burning an arc light in conjunction with and fed from the same machine as the Swan incandescent lamps; this is advantageous for surface lighting.

I cannot do better than indicate how I would propose to carry out a system of electric lighting for colliery purposes than by reviewing what I have purposed, with Mr. Swan's concurrence and approval, for Eppleton and Houghton pits, near Hetton, Durham.

1. The motive power to be Marshall and Sons best made horizontal engines, with their specially constructed automatic governor.
2. Siemens's exciter and alternate current machines.
3. Leading wire by Silvertown India-rubber and Gutta-percha Company, No. 1,092, having resistance of less than $\frac{3}{4}$ ohm per 1,000 yards.
4. Swan's lamps encased in specially-designed strong lanterns. Those that are fixed to have hemispherical glass globes and copper-silvered reflectors, suited for projecting the lights downwards or along the gallery or seam as desired; and those that are movable to be placed in lanterns like one or other of those before you, only lighter or more handy, specially strong 100-candle power Swan lamps being provided for the screens and other places where a strong light is desired.
5. For the open space surface works, and where the railway and surface haulage takes place, Siemens's (alternate current) arc lights are proposed, suitably placed to admit of working at night with a readiness and celerity almost equal to that in the day time.
6. Ayrton and Perry's electro dynamometers for measuring the strength of the electric current.
7. Velocimeter, switches, &c., as per specification.

The complete specification and estimate is drawn up with a view of entirely superseding gas and oil on the surface works, the three coal seams, and for stables and haulage near shaft, but not to be continued to the front at present, the distance being very great (two to three miles).

[At the same meeting Mr. Swan showed a miner's lamp, in which one of his incandescent lamps was combined with a small Faure accumulator, so that it could be charged, say, at the pit's mouth, and then entirely disconnected. By this means the lamp was rendered portable. Mr. Swan stated that this arrangement gave light for about six hours.]

NEW TOWN AT WAYNE, UNITED STATES.

The following account of a new town, for 3,000 inhabitants, to be built by Messrs. George W. Childs, of the *Public Ledger*, and A. J. Drexel, banker, is taken from an American paper:—

"Within a period of three years, the real estate along the line of the Pennsylvania Railroad has appreciated in value to the extent of 18,000,000 dollars. The first step in this extraordinary development was made ten years ago, when the Pennsylvania Railroad Company

bought 600 acres of land near White Hall, changed the line, named the new station Bryn Mawr, divided it into building lots, and sold it under such restrictions as to attract the wealthiest classes of the community to that section. It was about a year ago that Messrs. Childs and Drexel bought 600 acres of land, at Wayne Station, for 240,000 dollars, the tract having a frontage of a mile and a-half on Lancaster avenue, and on the railroad. It is the purpose of these gentlemen to divide the land into building lots of about an acre each, to erect artistic cottages, ranging in price from 2,000 dollars to 8,000 dollars, and to dispose of the houses and lots upon payment of about one-third the cost, Messrs. Childs and Drexel advancing two-thirds, thus affording to folks in moderate circumstances an opportunity of securing suburban residences upon reasonable terms. Within two minutes' walk of the new station, Mr. Childs has built the Bellevue Hotel, an ornate drab structure, in Queen Anne style, with porches on every side, which rise in tiers to the fourth floor. At the lower end of the tract another hotel, to be called the "Audubon," and capable of accommodating 150 guests, will be erected. Surrounding these properties and on Lancaster avenue will be five hundred residences, laid out on avenues having a uniform width of 60 feet, and footways from 12 to 15 feet wide. The houses recede 40 feet from the line of the avenue. Ornamental trees will be planted on either side. The roadway will be macadamized, and, with the forty-foot lawn between the house line and the footway, there will be a width of 170 feet between buildings on opposite sides of the avenue. To improve the landscape, Mr. Charles Miller, the chief of the Horticultural Department at the Centennial Exhibition, the Fairmount-park gardener, and the designer of the beautiful grounds at Woolton, Mr. Childs's country residence, has been engaged. The drainage system is under the supervision of Colonel George F. Waring, the sanitary engineer, whose advice was sought lately regarding the condition of the Executive Mansion at Washington. The water supply system, devised by Mr. Isaac S. Cassin, is now complete. It will supply a population of 20,000 people. The reservoir, covering nearly an acre of ground, and holding 250,000 gallons of water, is located on a knoll at the western end of the track, at an elevation of 450 feet above tide-water, giving a head of 82 feet. The water is supplied by springs, and is pumped from a pretty lake, where the flow of Ithan Creek is retained. More than two miles of six-inch distributing mains have been laid along the various avenues, the water works have been in practical operation for seven weeks, and everything is in shape to make connection when the buildings have been erected. At a short distance west of the Childs-Drexel property was the Spread Eagle Hotel property, a well-known stopping place on the Conestoga-road, where liquors were sold. This property was purchased by the two capitalists in order that no spirituous liquors might be sold near the site of their new city.

GENERAL NOTES.

Howard Medal Essays.—The Council of the Statistical have again decided to grant the sum of £20 to the writer who may gain the "Howard Medal" in November, 1882. The essays to be sent in on or before 30th June, 1882. The subject is—"On the State of the Prisons of England and Wales in the Eighteenth Century, and its Influence on the Severity and Spread of Small-pox among the English population at that period." The essays also to present a comparison of the mortality by small-pox among the prison population of England and Wales during the eighteenth century, with the mortality from the same cause during the last twenty years. Further particulars or explanations may be obtained from the Assistant Secretary, at the Office of the Society, King's College Entrance, Strand, W.C. London.

School of Art Wood-carving.—The School of Art Wood-carving has re-opened after the usual summer vacation. Free studentships in both the day classes and the evening classes are at present vacant. These studentships are maintained out of funds provided by the City and Guilds of London Institute for the Advancement of Technical Education. The necessary information, with forms of application and prospectuses of the school, may be obtained by letter, addressed to the Secretary, School of Art Wood-carving, Royal Albert Hall, Kensington, S.W.

Melting Steel.—On Tuesday, October 11th, the members of the Iron and Steel Institute visited the Telegraph Construction Works of Messrs. Siemens Brothers, at Charlton, on which occasion Dr. Siemens, F.R.S., exhibited his experiment of melting steel by means of the dynamo-electric current, when five pounds of steel were melted in five-and-twenty minutes. The apparatus employed consists of an ordinary crucible of plumbago, or other highly refractory material, placed in a metallic jacket, or outer casing, the intervening space being filled up with pounded charcoal, or other bad conductor of heat. A hole is pierced through the bottom of a crucible for the admission of a rod of iron platinum or dense carbon, and the cover of the crucible is pierced for the reception of the negative electrode, which is suspended at one end of a beam by means of a strip of copper. The other end of the beam is attached to a hollow cylinder of soft iron, free to move vertically within a wire solenoid, one end of which is connected with the positive, and the other with the negative pole, of the electrical arc.

Anderson's College.—Dr. Mills, F.R.S., "Young" Professor of Technical Chemistry at Anderson's College, Glasgow, has issued a syllabus for the session 1881-82:—A course of fifty lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on November 7th. The lectures will be illustrated with experiments, diagrams, and models, as well as by the actual inspection of manufacturing processes; and the progress of the students will be tested by periodical examinations. The earlier lectures will have reference to units of weight and measure, to the calculations necessitated by chemical operations, and to the nature and laws both of the chemical process and its results. A particular subject will then be considered in comparatively minute detail, embracing for this session dyeing and printing. A subsequent course of thirty lectures will be delivered, which are more particularly intended for dyers, colour manufacturers, brewers and distillers, tar rectifiers, drysalters, and others interested in a knowledge of technical organic chemistry. Mr. J. Snodgrass, senior assistant, has arranged to deliver a series of thirty lectures and demonstrations on physico-chemical measurements, and also a course of evening lectures on iron and steel manufacture, in time for the May examination.

Ladies' Sanitary Association.—A Second Series of nine lectures on "Domestic Sanitation" will be delivered by Dr. Richardson, F.R.S., in the Lower-hall, Exeter-hall, Strand, during October, November, and December. In this course of lectures the structure and functions of the nervous system of man will be presented. The physical and mental training of the young will be considered in this division. The lectures will be illustrated by the oxy-hydrogen lantern. The first lecture will be delivered on Saturday, October 22nd, at 5 p.m., and will be continued on following Saturdays until December 17th. Tickets for the Course, one guinea (transferable). Single tickets, reserved seats, 3s., may be obtained of the Secretary, Miss Rose Adams, at the office of the association, 22, Berners-street, W. Unreserved seats, 1s., by payment at the door. Six prizes will be awarded to the most proficient students as follows:—First Morley Prize of Ten Guineas, and Second Morley Prize of Five Guineas, given by Mr. Samuel Morley, M.P.; Prize of Three Guineas, given by Miss Marshall; Prize of Two Guineas, given by Mrs. Richardson; Prize of One Guinea, given by Lady Mount-Temple; Prize of One Pound, "Consolation," given by Mr. W. Phillips. Certificates of first and second-class merit will also be awarded.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

COLOUR BLINDNESS.

By R. Brudenell Carter, F.R.C.S.

Lecture III.—Delivered Monday, May 30, 1881.

Industries chiefly affected by colour-blindness—Engine-drivers, pilots, artists, letter-sorters, drapers, painters, &c., &c. Recent legislation affecting colour-blindness in America, and urgent need for it in this country. Conclusion.

In the course of the two preceding lectures, I have endeavoured to show that the sense of colour depends upon the nature of the light which is transmitted from visible objects, and that what is called colour-blindness depends upon want of sensitiveness, on the part of the optic nerve, to particular magnitudes of wave vibration, so that the colour sensations which these vibrations excite in normal eyes are not perceived, and the corresponding colours are invisible, and are lost out of all the admixtures into which they normally enter. Thus, in looking at what we call purple, which is a mixture of red and violet, the person who is blind to red sees in it only its violet element, and selects blue or violet to be a match with it. The red-blind, in a similar manner, loses the red element from all colours or mixtures of colours, and the green-blind loses the green element; while, to both of the latter, the difference between red and green is imperceptible, except as a difference of brightness or luminosity; green appearing the brighter of the two to the red-blind, and red to the green-blind. In the case of persons who are incompletely red-blind, or incompletely green-blind, the difference between the two colours is only recognised as a difference of luminosity at a distance, and becomes recognised as a difference of colour on a nearer approach; the precise point at which the difference of colour becomes apparent varying, for equal luminosities, very widely in different cases, and furnishing a measure of the degree of the defect.

I have already mentioned that there are a few cases of total colour-blindness, or of people who see nothing but form and light and shade, but these, and also blindness to violet, are of such rare occurrence, that practically they scarcely call for consideration. My chief business to-night is to discuss the bearing of red-blindness or of green-blindness, either complete or incomplete, upon the fitness of the subjects of these defects to engage in certain industries, of which those which call for the recognition of railway and marine signals are the chief.

If we take as an illustration, in the first instance, the state of an engine driver who is completely red-blind, and who is called upon to govern the course of a locomotive in obedience to certain coloured signals, which may be either red and green alone, or white and red and green, in accordance with the regulations of different roads, we find that these signals present to him differences by which, in many cases, he can tell them apart; but these differences are of brightness, or luminosity, and not of colour. From the white light he receives the whole of its green and violet, the red being lost to him, so that what he sees is a blue gray, comparatively feeble in brightness when contrasted with the impression made by the same light upon a normal eye. The green light will be removed still farther from the brightness by reason of its preponderance of green, and the red will only be visible by means of the rays other than red which the red glass transmits, and if nothing but red was transmitted, would be invisible altogether, so as to be what an Irishman might perhaps call a dark light. For practical purposes, however, we may omit the white lights from consideration, and may fix our attention only upon the red and green. Of these, the former, to a red-blind man, would seem darker than the latter; and this reflection would be reversed in the case of a green-blind. We may perfectly well suppose the colour-blind person, in either case, to be unconscious of his defect. He has all his life been accustomed to interpret the phrase "a red light" as meaning something which presents to him a dim or feeble illumination, and to interpret the phrase "a green light" as something which presents to him a stronger or brighter illumination. By the help of this distinction, he may pass an examination which is inadequately conducted, and he may drive his engine for long periods without accident or mistake. But the point at issue is that he is compelled to rely upon an unreal distinction, a distinction of relative brightness only; and that his judgment upon this relative brightness is liable to be misled by accidental circumstances. Anything which increased the apparent brightness of the red light, as, for instance, a better burning, or even a quite recently lighted lamp, a red glass of less thickness or slightly different tone, or of less absorbing power than usual, these and many other other possible variations would lead him to mistake a red light for a green one. In the same way, anything which diminished the apparent brightness of a green light, as a thicker or more absorbing glass, a badly burning lamp, the intervention of steam, smoke, or fog, would render him liable to commit the comparatively harmless mistake of taking a green light for a red one. To the green-blind, on the other hand, the reverse conditions would obtain. To him, the green light would be comparatively dim, and the red one comparatively bright; so that any of the conditions which would brighten the red light and make it more conspicuous to the normal sighted, would render it more like green to the green-blind, and would directly serve to tempt him into danger. It has been well

observed by Dr. Joy Jeffries that no right minded and conscientious person would undertake the guidance of a train, on the announced condition that, in any variations of atmosphere and weather, he was to recognise a dim light as a danger signal, and a bright light as a safety signal, and *vice versa*, and that his own life, and the lives of the passengers, were to be dependent upon his always rightly determining which was which.

It has often been maintained that we hear very little of accidents actually arising from colour-blindness; but it must be remembered that, until quite lately, this cause of neglect or mistake of signals was scarcely recognised by those whose duty it is to investigate such occurrences. At the present day, the first inquiry which would be made, in any case of over-running a danger signal, would have reference to the colour vision of the man in charge of the engine; but, even so lately as two years ago, the point would have been likely to be wholly overlooked. Admitting, as must no doubt be done, that the calling of an engine driver affords no immunity from colour-blindness, and that the colour-blind engaged in it, in default of measures for their discovery and rejection, are in the ordinary proportion of from four to six per cent., it is almost assuming a miracle if we say that accidents have not happened from conditions apparently certain to produce them.

The latest statistics of the examination of persons employed on railways with which I am acquainted are those collected by Dr. Joy Jeffries; and, in estimating their significance, it is necessary to remember what I mentioned in a previous lecture, that colour-blind railway servants have a tendency to eliminate themselves from their situations, by mistakes which do not lead to accidents, but which are noticed by their superiors, and are set down to drunkenness or carelessness, and held to require dismissal. Notwithstanding this:—

Dr. Hansen, a distinguished ophthalmic surgeon of Copenhagen, of whom I may observe in passing that my personal knowledge of him would lead me to place implicit reliance in the accuracy of his observations, states that among 1,034 railway servants in Denmark, there were 31 colour-blind, or 2·87 per cent.

Dr. Stilling, of Cassel, reports 24 colour-blind among 400 railway servants, or 6 per cent.

Dr. Magnus, of Breslau, reports four per cent. among railway servants tested by one of his colleagues, but does not give the total number examined.

Professor Donders, of Utrecht, with the assistance of Dr. Bouvin, examined 2,203 of the *employés* on the Dutch railroads, and found 152 colour-blind, or 6·9 per cent.

Dr. Von Reuss found 3·50 per cent. of colour-blind among 800 *employés* of one of the Vienna roads.

In the Swedish army, Professor Holmgren found 60 colour-blind among 2,200 men, or 2·7 per cent., and used this fact as a means of obtaining an examination of the railway servants throughout the country. In the first 266 men tested, there were 13 colour-blind, or 4·8 per cent., and the Professor has since examined 7,953, among whom there were 171 colour-blind, or 2·15 per cent. In Finland, there were 60 colour-blind among 1,200 railway servants, or 5·0 per cent., the examination being conducted by Dr. L. Krohn, after instruction by Professor Holmgren in his method. Nearly the whole of these examinations were conducted in the latter part of 1877; and they show that at that time, in the comparatively small amount of mileage and extent of country which they cover, there were no less than 479 colour-blind persons engaged in the actual conduct of railway traffic. These figures include all sorts of people, drivers, stokers, pointsmen, porters, and the like, for many of whom, in their ordinary occupations, their defect might not be a source of danger, but who would be liable, in all probability, to be concerned in signalling or in obeying signals, at least sometimes. It is a significant fact that some among them were station-masters.

Dr. Joy Jeffries quotes from Dr. Minder, of Berne, a narrative which is of sufficient interest to be repeated. Among Dr. Minder's cases was that of "a very intelligent young man who was red-blind, but was not aware of it. He held the position first of stoker, and then of driver on one of the Swiss roads. He was hardly at work before his defect troubled him. Thinking it was due to the spirit he drank, he stopped this for a while; but, the trouble continuing, he became convinced that 'something was wrong with him about the colours,' and left the recognition of the signals to his normal-sighted assistant. When another man, who seems also to have been colour-blind, took this assistant's place, the work began to be 'uncomfortable.' The red-blind driver had no one to correct him; and, as he was very frequently mistaken in his conclusions, there occurred a series of mistakes, fortunately only while manœuvring in stations, which brought upon him occasional fines and other disagreeable consequences.

"The red signal lantern gave him the most trouble, because, as he said, he could only distinguish it when so near with his engine as not to be able to stop, and hence often ran by it. He did better with the green signal; and, when asked why, replied, 'because it was brighter.' To the question how, then, could he tell the green signal from white, he, in a roundabout way, compared green to weak white; and stated that, with a lantern of white glass, he could, by screwing the wick up and down, and thereby changing the amount of light, himself imitate the usual railway signals. Very bright light was white; very weak light, red; medium intensity, green—in complete correspondence with the statements based by Holmgren upon the Young-Helmholtz theory. The apparent impossibility of his power of distinguishing between the lights being dependent only on their relative intensities induced me to search farther, and to ascertain what a complete colour-blind understood by pure white. A whole series of colour-blind persons were expressly asked to select only the purest white from among the test objects presented to them. Of worsteds and papers they picked out, besides the white, several shades of bright green, gray, pure gray and dirty gray, light rose, and very light violet." This entirely corresponds, it will be observed, with the illustration of the appearance of white to the colour-blind which was given by means of revolving discs in my last lecture, and which we will repeat on the present occasion.

In my first lecture I mentioned as a matter of probability, and was misreported in some papers as having stated as a fact, that there are in the United Kingdom more than 400 colour-blind engine drivers. As far as I am aware, the facts have not been ascertained, and my statement was based upon these grounds. According to the Board of Trade returns, the locomotives in use in the United Kingdom during the year 1879 were 13,174. There is no information with regard to the number of these which were in actual running order; but the statistics of the South-Eastern Railway, for the successive half-years between June, 1875, and December, 1879, show an average of 73·3 per cent. of the locomotives as running at any given time, while 26·7 per cent. were in the shops under repair. On the basis of these figures, kindly furnished to me by Mr. Price Williams, I assume that, of the above-mentioned 13,174 locomotives, 70·0 per cent., or 9,222, were always in running order, and were therefore giving employment to the same number of drivers. I assume farther that, among these 9,222 engiue drivers, little or nothing having been done to weed out the colour-blind, there will be the same proportion of this defect which has been recently discovered in the Metropolitan Police, or 4·67 per cent. This percentage, upon the number stated, would give a total of 424 colour-blind men.

The question may here be fairly asked, whether it is true that little or nothing has been done to weed out the colour-blind from such an employment as engine-driving; and I fear there can be no doubt that the answer must be in the affirmative. I do not know of any official returns upon the point, and I have been told that some companies have instituted an examination into the colour-vision of their servants, and of all candidates for employment. This is no doubt highly satisfactory as far as it goes, and may at least lead to effectual precautions in the future, but there is no evidence that it has accomplished anything at present. The subject is a new one; or rather, as I have already stated, it is one which has only recently emerged from the position of a matter of scientific curiosity into that of a matter of practical importance. The attitude of mind of railway authorities with regard to it was, in the first instance, that attitude of passive resistance which the human mind is so apt to assume in the presence of suggestions for improvement. It is a familiar saying that people meet every discovery by first saying that it isn't true, then that it isn't new, next, that they have always known it. Now the first suggestions that colour-blindness was a common affection, and a source of actual peril in railway working, were met with absolute denial and entire incredulty. As soon as the railway authorities were driven from this first line of defence, some of them said "well, we will institute examinations." At this stage they seem to have believed, I think not unnaturally, that the question was a very simple one, which anybody was competent to decide; and the result of this was that they committed the examinations to the hands of incompetent persons, who used methods which, as I showed in a previous lecture, were not only valueless, but misleading. The truth is, that the testing of colour-vision, in a way to be at once fair to the employers and to the servants, is a matter which requires very considerable practical experience not only of this particular defect, but also of the methods of testing vision generally. I believe it to be impossible for any but experts to conduct the examination of a large number of men at once with correctness and with accuracy, and I have no doubt that serious errors have been committed from the want of recognition of this fact. I may be pardoned for pointing out that even the medical officers of a line of railway, whose ordinary duties have little or no relation to vision, are not always experts with regard to it; while the examiner often employed, some worthy person who has been promoted from being a porter to be an inspector, would be sure to blunder in every direction, and, in the rashness of pure ignorance, would constantly decide upon inadequate grounds. I have heard, although I do not vouch for the truth of the statement, that the examiner employed upon one line of railway, was himself, after he had been for some time engaged in the duty, accidentally discovered to be colour-blind; and it is astonishing how few persons, even of fair education and ordinary intelligence, are at first able to emancipate themselves from the confusion incidental to the correct or incorrect use of colour-names, which, as I have already pointed out, have no necessary connection with colour-vision. In the report drawn up by Dr. Brailey, for the committee of the Ophthalmological Society, from which I have already quoted the statistics of colour-blindness in England, I find the following passage, which is based upon his observation of the examination of more than 18,000 persons, by 16 highly competent observers. He says:—"The value of the service rendered by the examiners has in most cases been enhanced by its having extended over the whole five months during which the facts have been accumulated; so that increasing skill has been attained, and more uniformity of result has been secured. Your secretary becomes more and more convinced that a competent examiner is not made in a day, or even in a month; and that, even with large experience, much judgment and capacity are needful to interpret rightly the acts of the examined, whether educated or uneducated. This necessity is perhaps most strongly exhibited in the case of the partial colour-blinds of intelligence; who, although they may have a much feebler appreciation of the difference between red and green, for example, than the normal, may, after accurate observation and comparison, separate the red wools from the green. When tested, however, with coloured lights, their defects come out strikingly; and it becomes clear that they are totally unfit for responsible posts in which rapid appreciation of colour at a distance is required."

A remarkable instance of the difficulties which are sometimes placed in the way of the examiner, and of the care and skill and knowledge which he may be required to exercise, is furnished by a narrative contained in the last annual report of the Supervising Surgeon-General of the Marine Hospital Service of the United States. The narrative is too long for quotation, but I will endeavour to condense its most essential features. It is in the form of a report, by Surgeon Hutton, on the case of a colour-blind pilot at Detroit.

According to the rules issued last year by the United States Government, all persons applying

for either a renewal of license or an original license on steam-vessels are required to undergo a visual examination, in order that it may be determined whether they can properly determine the coloured lights used as signals on steam vessels; and the inspectors cannot issue pilots' licenses without first receiving a certificate from a surgeon of the United States Marine Hospital Service that the applicant fulfils all the requirements of the rule referred to. A later order empowers the local inspectors of steam vessels to re-examine with coloured lights those applicants who are reported by the Marine Hospital Surgeon as *incompletely* colour-blind, and to issue licenses to them, if satisfied by the results of this examination that the applicants are able to distinguish coloured lights. I may here interpolate that attempts have been made in the United States to make political capital out of the question of colour-blindness, and that hence the authorities have been somewhat hampered in their efforts to deal with it on scientific and practical grounds alone, and have been led from time to time to modify, out of consideration for cases of real or supposed hardship, the rules under which their officers are instructed to act.

On the 21st of August, a prominent citizen and shipmaster of Detroit was sent to Surgeon Hutton for examination, and was reported by him to be completely colour-blind. The local and supervising inspectors called upon the surgeon to suggest that there must be a mistake, saying that the applicant had sailed vessels for 32 years, 24 of them under a pilot's license, that some, if not all, of the inspectors had sailed with him, and were certain that he could distinguish coloured lights as well as the best, and that he had never made a mistake or met with an accident. They wished to have a certificate of incomplete instead of one of complete colour-blindness, as the former would have referred back the matter to them, while the latter left them powerless. Mr. Hutton replied that the applicant was either completely colour-blind, or not colour-blind at all; but he accepted the invitation of the inspectors to see him informally tested with coloured lights. A room in the Custom-house was darkened, and a lantern was so arranged so as to show either a white, a red, or a green light, and was placed at 20 or 25 feet from the person examined. The light used was about six inches in diameter, but being transmitted through a bull's-eye appeared larger, say eight inches in diameter. Several times the examined pronounced the red to be green, the white to be green, and sometimes the green to be red. Splitting the light so as to show the port or left half as red, and the starboard or right half as green, precisely as they appear as to position on shipboard, he every time said both sides, or halves, were green, but of different shades.

On the 25th of August he had another examination. The light green skein of Holmgren's first test was shown him, and he was told that it was green, and was desired to select from the pile anything of the same colour without reference to shade. He selected one of the same shade, 2 of No. 1*, 3 of No. 2, 2 of No. 3, 1 of No. 4, and 1 of No. 5. For test No. 2, he selected one of the same shade, 4 of No. 6, and 3 of No. 7. For test 3, he selected 6 of brightest red, 3 of No. 11, and also 3 of No. 10, but finally rejected them. Again, red being shown, he matched it with 8 of brightest red, 4 of pure brown, and 1 stone grey.

Green of the best being shown, was matched with 7 green, 4 grey, 8 brown, and 1 yellow.

Grey shown, was matched with 4 grey, 4 brown, 2 green, and 2 yellow.

Brown shown, was matched with 4 brown, 3 green, and 1 red.

Blue shown, was matched with 4 blue, 5 violet, and 3 red.

Purple shown, was matched with 2 violet, 5 blue, and 2 red.

Yellow shown, was matched with 6 yellow, and 2 yellow-green. About an hour and a half was occupied in the investigation, and he always held the test sample in one hand, and carefully compared with it every other which he examined. Dozens of skeins of each colour were also compared and rejected.

Four skeins each of good green and grey were then taken from the pile, mixed together, and placed apart. Asked how many there were, he replied, eight, of course. He was then told that four were of a good green, and four of a good grey, and was asked to separate them, by selecting the greens. In his best endeavours he selected two of each, but more frequently all, or nearly all the greys, saying, as to the greens, that they had a reddish cast.

After a variety of other tests, all bringing out the same results, the applicant was taken out in the streets and on the river, at night, by his friends and by the inspectors, who stated that he could readily distinguish red and green lights in drug stores and on vessels. They appealed again to Mr. Hutton, saying that it was impossible to confound him with coloured lights in the street or on the shipping in the harbour. These statements were so persistent that a practical trial of this kind was arranged. After an examination with the worsteds by gas light, in which the same mistakes were made as in the day, the party proceeded into the streets, and from here I take Mr. Hutton's words. "Three or four blocks away, up Griswold-street, a series of four red and six green lights, arranged in a triangular form over a saloon, were pointed out. These he properly described; also, a single red light on a car on Larned-street. Turning on Woodward-avenue, two street cars a block away, standing side by side, one showing a green and the other a bright light, were pointed out to the applicant. The bright light was pronounced green, and the green light was pronounced red. Several attempts were made to have him correct his mistake, but he persistently adhered to his statement that the green light was red and the bright light was green. Several red, green, and bright lights were then shown to him on Woodward and Jefferson Avenues. He made one or two mistakes on the reds, stating that they appeared green to him; some green lights were called red, and nearly every bright light was described as green.

"On the river he made fewer mistakes; two red lights and one green light about a mile down the river were pointed out; of these he made out one red, but not the others. Two stationary red lights on the shore being pointed out, he said

* These numbers refer to those in Holmgren's Chart of Confusion Colours, which was exhibited to the audience.

he saw one, but no other. Three moving red lights were properly named. Three of same in opposite direction were made out as two only. He 'saw' green lights when none existed; also, in one instance, pointed out a red light when none existed. On the switches of the Great Western Railroad he made out both red and green lights, but it was impossible to separate them. Returning to Detroit, he again made mistakes as to street-car lights. Passing along Woodward-avenue, we stopped opposite Frizell's drug store, in the windows of which were eight coloured globes, red, green, and yellow. In order that no mistakes, as to the light and colour examined, might be made, the supervision inspector crossed over, and with his cane pointed them out one by one; of the eight coloured globes, all brilliantly lighted, he properly named one, yellow; a green globe he said was red, and a red globe three or four feet above the green he said was green.

"I had entered upon this last task with the determination that if the applicant made no mistakes in the test, as some of the inspectors and the applicant were so confident he would not do, I would give him the benefit of it so far as it lay in my capacity, and would proceed to criticise the trustworthiness of the worsted tests. But, when tried on lights of which he knew nothing, it confirmed what I decided within five minutes after commencing the first examination, and showed that my diagnosis of completely colour-blind would stand. So far as the test on the river among vessels is concerned, I maintain that it is no test at all. Vessel lights have fixed positions. A progress of mental calculation, coupled with his knowledge of the relative positions of these lights, enabled him to decide the matter, after a little reflection as to the position and course of the vessel, independently of his chromatic sense.

"An amusing instance corroborative of my diagnosis occurred on the last morning. He walked into my office remarking, 'Doctor, you say I am *completely* colour-blind; you *know* I can see red; I'll show you.' Walking up to the table on which was spread the worsted—and although, in order to give him the benefit of every doubt, I had purchased a dozen or so of samples of the brightest red, pink, blue, and green, and put away all doubtful samples—he seized a skein, and approached me, remarking, 'there is as good a red as God Almighty ever made.' However, it was the best of brown."

I think there can be no doubt that the applicant in the foregoing case, if it had not been for the firmness of Mr. Hutton in the discharge of his duty, would have been referred to the inspectors for further examination, and would by them have been permitted to return to his avocation, on the strength of the insufficient test furnished by the names which he applied to the moving lights of steamships.

That colour-blindness constitutes a real peril in the conduct of navigation is curiously illustrated in the report for the current year of the railroad commissioners for the State of Connecticut, who say: We hear less frequently the question so common six months ago, "Who ever heard of an accident from colour-blindness?" Many accidents which, when the fact of colour-blindness was less known, seemed unaccountable, are now found to have all the characteristics which would be expected in accidents from colour-blindness, and in some instances the proof is conclusive. The following is a remarkable instance of this.

A few years ago a collision occurred near Norfolk, Virginia, between the tugboat *Lumberman* and the steamship *Isaac Bell*, resulting in the loss of ten lives. A coroner's inquest was held without definite result, the general impression being that one or the other of the pilots was intoxicated. There was no proof of this, however, and the pilots were released. The pilot of the tugboat *Lumberman* was examined by the surgeon of the marine hospital service, during the current quarter, and found to be colour-blind. A rumour has reached the marine hospital bureau that the pilot of the *Isaac Bell* is also colour-blind.

Evidence, uncertain it is true, but of some weight, of accidents through colour-blindness may be found in the results of our Connecticut examinations. Dr. Carmalt says that he found no engineer over 31 years of age who was colour-blind, and the total average was only three per cent. in the State. Now, as it is agreed that about four per cent, is the average among men, and as our men examined were largely old *employés*, we may fairly assume that about one per cent. had been eliminated through mistakes, in fact caused by colour-blindness, but, as that was not thought of at the time, they were discharged for what was called carelessness.

In the face of the facts and arguments already stated, it becomes a serious question what precautions should be taken by the governing bodies of railways, if necessary under compulsion from the legislature, to secure the traffic of their respective lines against the risks which colour-blindness seems in the long run certain to entail. Considering the extent and character of these risks, and the inadequacy of any other defence against them, I think it is not too much to require that the colour-blind, for the future, should be absolutely excluded from railway or naval employment. The absolute number of persons affected by such a provision would, no doubt, be large; but the comparative number would be small; and there is no real hardship in excluding four per cent. of the male population from duties which they are not qualified to fulfil. The subject is one which might with great advantage be taken up by the amalgamated engineers and other trade societies, or, better still, by school boards, with a view to the early testing of the colour vision of children and of candidates for apprenticeship, and in order to exclude the colour-blind from occupations for which they are unfit, before they had spent time in preparing for them. Failing this, a strict examination should certainly be instituted by all railway companies, and no man should be permitted to enter their service, in any position in which colour-vision was or might be required from him, unless the results of the examination were entirely satisfactory.

It is strongly held by the majority of ophthalmic surgeons that every such examination should be conducted by trained experts; and in the United States, where this opinion has already found legislative expression, it is certain that passengers would not consider their safety adequately provided for, and that engine drivers and others would not submit to be condemned, by any verdict save that

of a trained scientific observer, thoroughly conversant with the whole range of the phenomena which he was called upon to investigate. In this country, at the present time, public opinion is hardly prepared to insist upon such an examination as this, and moreover, in its influence upon railway companies, it is singularly feeble. I would venture to suggest, as a compromise between what is theoretically desirable and what is practically capable of enforcement, that the preliminary examination of all candidates for employment should be left in the hands of the ordinary officers of the companies, acting under scientific instruction, and that doubtful cases should be referred to experts. It would be very easy for the companies to arrange with experts to examine the cases referred to them at some stated fee, and then to say to candidates for employment, whose cases were reported as doubtful, that they must obtain certificates from the appointed expert before they could be considered eligible for employment. Whether the fee should be paid by the company or by the candidate would be a matter of arrangement between them.

The mode of examination which I would suggest, as falling within the capacity of the officers of the companies themselves, would be very simple. I would let them call upon each candidate rapidly to sort into two heaps twelve skeins of wool, six of which should be red and six green, both in gradations of colour, and to throw all the red into one heap and all the green into the other. Any normal sighted person would accomplish this sorting very quickly, and with absolute ease and certainty; and any candidate who did this should be considered as having passed in colour. Any candidate who rapidly made a wrong selection should be rejected without hesitation. Any candidate who sorted his wools slowly, and as a result of careful comparison, would at least have defective colour sense, and should be referred to experts to decide upon his exact condition. He would probably belong to the class of the incompletely colour-blind; whose condition is such that they can distinguish red from green in certain circumstances and at short distances, but not under all circumstances, nor at all distances. It would then be the duty of the expert to pronounce upon the degree of the defect, and it would be the duty of the railway authorities to decide whether that degree amounted to a disqualification in the course of the particular man; due regard being had to his capacities in other respects, or to his claims, from past service or other causes, upon the consideration of his employers.

The visibility of an object depends upon the size of the surface within the eye which is covered by its image; and this again upon the two elements of size and distance, which govern the dimensions of what is known as the visual angle. The result of this is that we take objects of known magnitude, placed at known distances, and determine the acuteness of vision by dividing the distance at which any such object is recognised by the distance at which it ought to be recognised. In the same way, we can express the degrees of incomplete colour-blindness by the distance at which a given red light, or a given green light, would be recognised; and, when we have arrived at the normal standard, we can express all that falls short of it by a fraction. Thus, if a normal eye would recognise the character of a given light at a thousand yards, and an incompletely colour-blind person could not recognise it until he had approached within five hundred yards, the latter would have only half acuteness of colour-sight as compared with the former. An ingenious apparatus for determining this point is in use on the Belgian State railways. In principle it resembles the lamps of Professor Donders and of Mr. Nettleship, but it differs from them in details. The aperture through which the light is transmitted is covered by a disc furnished with what is called an "iris diaphragm," that is, a contrivance by which the size of the opening may be regularly increased or diminished by the action of a lever, the circularity of its outline being all the while maintained. Behind this variable aperture is another disc carrying coloured glasses. The person to be examined is placed five metres from the instrument; and a disc of coloured light is shown to him of such brightness and magnitude as a signal lamp, in clear weather, would present at 700 metres. He is not permitted to use any colour-names, but is directed, as soon as he sees a danger signal, to call out "stop," and as soon as he sees a forward signal to call out "right." If he makes no response when the light is first exposed, the lever is moved in such a way as to enlarge the luminous opening at the rate in which an actual signal lamp would appear to be enlarged to a driver approaching it at thirty miles an hour; and, as soon as the man calls out anything, either rightly or wrongly, the size of the aperture is read off, and the examination continued as long as may be required. In this way the expert becomes able to say that the candidate, instead of distinguishing the lights at 700 metres, confuses them until they come within, say, 100 metres, and it is then for the authorities of the line to determine whether this degree of colour-sight is sufficient for the duties about which the man would be employed. To some extent, of course, the question of the sufficiency or insufficiency of incomplete colour-vision is a question of the efficiency of brakes, and the less efficient are the brakes with which any train is provided, the more important it becomes that the driver should be able to recognise colour signals at the normal distance.

The Nautical Department of the Board of Trade, now for the last three years, has insisted upon an examination in colour as a preliminary to the professional examination for candidates for masters or mates' certificates, and there can be no doubt that great credit is due to this department of the Government for its prompt recognition of the requirements of the public safety in this respect. According to an official return, only 26 candidates were found to be decidedly colour-blind out of 5,967 examined in two years, or 0·43 (less than one-half) per cent. This small proportion points to one of two conditions, either an imperfect method of conducting the examination, or else the elimination of a large number of colour-blind persons as the result of private examinations directed to the same point. I think it is probable that both causes concur in the production of the result.

The examination by the officials of the Board of Trade was arranged prior to the more exact knowledge, which has lately been attained, of the actual

conditions into which inquiry should be made, and it is conducted in the following manner. The examiner is furnished with thirty cards, of which five are white, five black, five blue, five red, five green, and five yellow, the colours being all saturated. Shuffling the cards, he withdraws now one, now another, and, suddenly showing it to the candidate, asks what colour it is. Correct names are accepted as evidence of correct colour-vision; and the examination is carried further by pieces of coloured glass, held up between the person examined and a window. Now I think it quite possible that an intelligent man, trained, as the colour-blind often are trained, to study slight differences of luminosity, might conceal colour-blindness throughout such an examination. Assuming him to be red-blind or green-blind, and these are the most common forms, he would be in no danger with the rest of the cards, and the very saturated reds and greens would present to him marked differences of luminosity. I think that a case of incomplete colour-blindness, which might entail great danger from incapacity to recognise colour signals at sufficient distances, might entirely escape discovery. For naval purposes, the examination cannot be confined, as in the railway services it may be, to red and green alone; on account of the various colours of signal flags; and I think it might be rendered perfectly safe by the same method which I have suggested for railways, a little modified to meet the altered circumstances. The examiner should, I think, have his tests in wools, with five or six shades of each colour, and the candidate should be required to sort them rapidly into heaps.

It is not the practice of the Board of Trade to refuse certificates to colour-blind applicants, but only to endorse the fact of colour-blindness upon the certificate. In this way the officer himself, and his employer, are alike warned of his defect, and, while he may be engaged on account of his other capabilities, neither he nor they will have any excuse for trusting to his power of discriminating colour-signals. If the wool test were adopted in the service, I would suggest further that, as in the case of railways, the subjects of incomplete colour-blindness should be tested by experts with reference to degree, and that this should be endorsed upon the certificate as well as the complete forms of the affection. I trust, however, that the time is not far distant when proper examinations during childhood will prevent persons from taking the first step in callings for which they are manifestly unfit.

I have left myself very little time in which to speak of the influence of colour-blindness upon other callings; and, in the few words which I can devote to this part of the subject, I may mention that it seems to be really an advantage to engravers, and generally to all persons who produce illustrations in black and white, on account of the increased acuteness of perception of the variations of light and shade to which it appears to lead. In many other callings it presents a serious impediment to success. There was a clerk in a Government office in London whose desk was furnished with three bottles, containing respectively, red, blue, and black ink; and he only knew which was which by placing them before him in some definite order. It was the pleasure of mischievous boys in the office, who had found out the clerk's defect, to change this order whenever his back was turned; and the result was that he used to bring to his superiors parti-coloured letters for signature. He was transferred to a department where it was his duty to tick off certain entries with black ink and others with red; and here he succeeded in producing a confusion which has hardly yet been disentangled, and which utimately led to his dismissal. Dr. Joy Jeffries tells me of a portrait painter in New Boston, so skilful in his drawing that he gets £100 or £200 for a portrait, but who has to employ somebody else to mark his reds and greens before he ventures to use them. He also mentions three brothers who are colour-blind. One of them was a carriage painter, and he had to have his paint-pot given him by somebody else before he could begin to work. Another was in a furniture store, and could not rise above a packer, in consequence of having tried to persuade an old lady to buy a red sofa to match with green chairs. The third was in a large dry goods store, but could do only menial work in consequence of his defect. Dr. Jeffries also tells me of a medical student, who was plucked in his examination on account of errors in discriminating the actions of chemical tests, which were afterwards discovered to be due to colour-blindness; and in his book on the subject he mentions the case of a post-office clerk in Prussia, who was found to be constantly wrong with his accounts about the stamps. But at length it was discovered that he was colour-blind, and could not distinguish red from green stamps, so that he was perpetually in error about his charges for those which he issued to purchasers. A volume might be written about the possible mistakes of the colour-blind, but it would not materially advance our knowledge for any practical purpose. The most remarkable are those committed, when two colour-blind persons reinforce each other, as in the case of the gentleman who went to match some red wools for his wife, and succeeded, by the luminosity of sample, as long as only the bundle of red wool was brought to him to select from. At last a time came when a colour-blind shopman brought him a bundle of green wools, and from this the two together selected their matches for the red with entire complacency.

In a large number of civilised countries, the facts which I have roughly brought together in these lectures have already induced steps to be taken by persons in authority to provide against the dangers of the situation. In England, as I have stated, the Board of Trade was early in the field, and, thanks to the powers committed to it, is able to afford protection to the mercantile marine without a special act of parliament being required. In Norway and Sweden, where railways are more under control than with us, similar arrangements have been made with regard to them. In various continental countries people are becoming more and more attentive to the subject; but the lead has been taked in the United States. Massachusetts was the first to legislate; and a stringent law has quite recently been passed in Connecticut, which requires the whole *personnel* of the railways of the State to be examined for colour-vision every two years by a "competent person;" a phrase which, if it were used in England, wonld furnish much employment to the gentlemen of the long robe.

The time is, however, quite ripe for some action to be taken in this country; and I think our past experience of railway management, as, for instance, in the almost kindred matter of brakes, shows that the companies cannot be trusted to do what the public safety demands. I have long felt that we shall never obtain the safety which the best form of brake is calculated to afford, until the question becomes so familiar to the public that, when accidents occur through inefficient brakes, juries remember the fact in estimating damages. The brake question, unfortunately, is a complicated one, permitting of a considerable conflict of assertion; but the question of colour-blind drivers and stokers is a comparatively simple one. It is much to be wished than an Act could be obtained which would compel all railway companies to have their servants tested for colour-vision by scientific methods; although it might fairly be left to the companies themselves to employ the colour-blind, if they chose to do so, in any capacity in which their defect was not a source of danger. But colour-blindness should at least be made known; and there should be no possibility of lives and property being sacrificed through ignorance of its existence.

MISCELLANEOUS.

CHINA GRASS DRESSING MACHINES.

By C. G. Warnford Lock.

I have just received from the Agricultural Department of the Indian Government a report on the trials of the China grass machines, which was intended for incorporation in the article on "Fibrous Substances" in Spons' "Encyclopædia." It has arrived too late for this purpose, but will probably interest readers of the *Journal.*

The seven competing processes may be thus briefly described:—

1. J. P. Vander Ploeg's appliances consisted of a crushing and a scutching machine; he cleaned the fibre finally by boiling it in a prepared liquor.
2. J. Nagoua used a combined crushing and scutching machine, adaptable to both operations.
3. R. H. Collyer boiled the stems first in water with a very little soda, then passed them through a machine which broke them up, and again through the same to clean them. He had also a smaller manual machine, costing only £60, but unsuitable for a regular factory.
4. Laberie and Berthet's machine crushed the stems, which were kept constantly wetted; the fibre was then steeped in a bleaching liquor and an alkaline liquor.
5. J. Cameron abandoned the machines described in his specification, and brought a hand implement.
6. C. F. Amery broke the stems in a crushing machine, boiled them in an alkaline solution, and again passed them through the breaking machine.
7. C. E. Blechynden steamed the stems, peeled them by hand, and then beat them by hand with mallets.

The reports of the experts upon all the samples turned out by the competitors concur in placing them far below the fibre imported into England from China, which is valued at £50 a ton. The most favourably received samples were Nagoua's, described as containing "some good fibre, and fairly marketable," and valued at £26 a ton; and three lots from Cameron priced at £15, £18, and £11 a ton respectively. One of Cameron's samples was approved of as being the best as far as freedom from bark was concerned; but the fibre was broken and tangled, would never give so large a yield of sliver as Nagoua's, and the sliver would not be so long. The brokers say that none of the samples are nearly up to the requirements. Nagoua's is the only one which could be used for China grass purposes, and this would only sell freely in a market bare of the regular article. Accordingly, the prizes originally offered will not be awarded, but certain of the competitors are recommended for smaller grants. The lesser value placed upon Vander Ploegs' fibre is attributed to the fact that he aimed at producing it in a finished state fit for the spinner, and not to the inability of his machines to compete with Nagoua's and Cameron's. It is also remarked that Cameron's process is but an improvement upon native methods current in India, and such as is applied in many of the Indian gaols for extracting aloe fibre; it can be employed upon green or dry, short or long stems, but would hardly be applicable on a plantation where many acres had to be cleared quickly. Therefore the recommendations are 5,000 rupees each to Nagoua and Vander Ploeg, and 1,000 to Cameron.

The committee conclude that, from the low valuation put upon the samples produced at the competition, it does not seem probable that the Indian product will yet be able to compete with the Chinese. But if the plant can be grown in the moist climate and rich soil of parts of Burma, Upper Assam, and eastern and northern Bengal, with only the ordinary care required for a rather superior crop, it may possibly succeed commercially. Until this has been satisfactorily proved, and a real need has arisen for effective modes of treatment, the Government has no intention of renewing the offer of prizes; and will content itself with maintaining some acres of the plant under cultivation, for supplying roots to intending growers.

Thus, even after much experience has been gained in the matter, and with every incentive to success, the machinists of Europe are compelled to confess their complete inability to match the manual work of the Chinese. It may be incidentally remarked that out of the seven competitors no less than four departed from their proposed plans, these four including all the English. This fact seems to indicate an imperfect previous acquaintance with the material to be treated, and amounts to an acknowledgment at the eleventh hour that they had been working in the wrong direction. This may probably help to account for their backwardness. On the other hand, of the remaining three, two (the Frenchmen) have presumably not neglected to experiment upon the plant which is under cultivation in the south of France, and they are in fact already well known among Continental textile machinists. The moral of this is the necessity for further experiment on the part of English machinists.

CINCHONA CULTIVATION IN BENGAL.

Surgeon-Major George King, the Superintendent of the Royal Botanical Garden, Calcutta, points out, in his last report, that the avowed object of Government in maintaining its cinchona plantations is not to grow bark for sale in England or elsewhere, but to produce raw material for the manufacture of cinchona febrifuge for the use of the people of India, but the plantations are now so extensive that attention can be paid to other besides the quinine-producing trees. This report, dated 28th May, 1881, is the Nineteenth Annual Report of the Government Cinchona Plantations in British Sikkum, and with it Dr. King's report, of the same date, has been received. The following is an abstract of the contents of these documents:—

The planting operations of the year were confined to

yellow bark trees and trees of the still unnamed hybrid variety. It has not been deemed necessary to increase the number of *Succirubra* trees, from which the cinchona febrifuge is manufactured. There are now more than four millions of these trees on the two plantations of Mungpoo and Sittong, and this is considered quite sufficient to provide red bark for a much larger consumption of the febrifuge than there is any reason immediately to anticipate. Endeavours have therefore been confined to increasing the stock of quinine-producing trees to meet the demand for sulphate of quinine in the hospitals and different departments of the Government service. There are two descriptions of these trees on the plantations, the supposed hybrid variety and the *Calisaya.* Of the former, which yields a bark rich in quinine, 90,320 plants were put out during the year, 85,320 at Mungpoo, and 5,000 at Sittong, and the total number now on the plantations is 199,898. Special attention has been devoted to the propogation of the *Ledgeriana* variety of *Calisaya*, which is especially rich in quinine, and 99,415 trees were planted out at Mungpoo. At Sittong 6,000 *Calisaya* trees were put out. There is a large nursery stock of *Ledgerianas*, and the permanent plantation of this valuable variety will probably be largely increased during the current year. The propagation of the species which yields the Carthagena or Columbian bark has been retarded by the attacks of the "thrip" pest. This species was only introduced in January, 1880, when the late Mr. Biermann brought out four plants of it. There are now 60 rooted plants and 90 partially rooted cuttings, and every effort will be made to increase the stock.

The total number of trees of all kinds planted out in the two plantations of Mungpoo and Sittong is 4,677,720, this amount being made up of the following items: — *C. succirubra* (red), 4,034,535; *C. calisaya* (yellow), 412,695; unnamed variety, 199,898; other kinds, 30,592.

The produce of the plantations of the year was 377,525 lbs. of dry bark, against 361,590 lbs. in 1879-80, and 261,659 lbs. in 1878-79.

A large number of trees of the interior kinds of *Calisaya* were uprooted during the year. This species includes several varieties, many of which, as Dr. King says, "produce barks which are essentially druggists' barks, being well suited for preparations, such as decoctions and tinctures, but being unsuited for the manufacture of febrifuge, and containing too little quinine to be worked profitably as sources of the pure sulphate of that alkaloid." There being thus no way of disposing locally of a considerable quantity of yellow bark, a consignment was sent to London for sale. The opportunity was taken to send a small quantity of good *Ledgeriana* bark to get some idea of its commercial value. Dr. King remarks that yellow bark of any kind from India had never before been offered in the London market, and that, indeed, except at Mungpoo, it is not grown anywhere in British India. The result was considered most satisfactory. *Ledgeriana* bark sold for 10s. 10d. per pound, and the inferior bark also fetched very good prices.

The introduction of the Java plan of shaving the bark of living trees to the height of from 8 ft. to 10 ft. from the ground was an interesting feature in the operations of the year. The results have been favourable, as under this plan the bark renews perfectly. Dr. King proposes to test by analysis whether the renewed bark is as rich in medicinal alkaloids as the original bark. But the Dutch plan of grafting *Ledgeriana* on *Succirubra* stocks, which was also tried during the year, was not attended with success. A further trial, however, will be made.

The general condition of the plantations is satisfactory. The growth of *Succirubra* in Sittong is not as flourishing as it might be; but *Ledgeriana* and the hybrid variety are thriving well. It is found that these two varieties grow better on land with a southern exposure than on land that looks to the north. It will thus be possible to utilise a considerable area which has hitherto been considered unsuitable for any kind of cinchona.

The total outturn of the febrifuge factory during the year was 9,296 lbs. The cost of manufacture, including the cost of the bark used, was Rs. 85,921 6a. 3p., and the average cost per pound rather less than last year. During the year 8,653 lbs. 13 oz. of febrifuge was disposed of as follows:—

	lbs.	oz.
To medical depôt, Calcutta........	3,000	0
,, ,, Bombay........	2,000	0
,, ,, Madras........	500	0
Sold to the public	3,150	11
Given as samples, &c.	3	2
Total........	8,653	13

The sales to the public are stated to be steadily increasing, and the febrigage is said to be daily increasing in reputation as a thoroughly good cure for fever.

The financial results of the operations during the year were very satisfactory. The receipts from the sale of febrifuge and seed and plants, and the sale of bark in London, amounted to Rs. 1,79,657 2a. 11p.

The actual profit exhibited on the year's working was 80,290 rupees, equal to 8 per cent. on the capital of the plantation, while the value of the stock in hand at cost price was 94,294 rupees. This, however, does not represent the whole of the gain of the year. The price of quinine was very high, and the cost of 5,550 lbs., which would have been used by Government had the febrifuge not been available, would have been, at the lowest estimate, 5,50,000 rupees. The cost of the febrifuge used was only 90,880. There was thus a clear saving of 4½ lakhs of rupees. The savings effected by similar substitutions of febrifuge for quinine in previous years amounted to 11¾ lakhs. The total saving therefore has already amonnted to more than 16 lakhs of rupees.

The expenditure for the year amounted to Rs. 71,705 10a. 4p., being between one and two thousand rupees less than the budget estimate and allotment. In making out the accounts, care is taken to keep the expenditure of each plantation distinct. Dr. King observes that "the account of the Sittong plantation ought, when it is completed, to be of much interest to Cinchona planters, as they will show at how cheap a rate a plantation can be put out, when the price of experience does not form, as it so often does in new enterprises, a very heavy item in the capital expenditure."

ANTIMONY DEPOSITS IN SONORA.

In the recesses of a short range of mountains, the Sierra del Alamo Muerto, which skirts the eastern shore of the Gulf of California, at about thirty miles from the gulf, and fifty miles from El Altar, are several silver ledges, which have been worked from time immemorial by the Mexicans, and have recently passed into American hands. The most notable, says a writer in the *American Mail*, is the San Felix, which has been burrowed into to a depth of 700 feet on the incline. On the northern flank of the range an area of considerable extent is strewn with quartz and a heavy yellow mineral. This is said to have been long ago amalgamated for silver, but to have yielded so base an amalgam (perhaps from the presence of a little native antimony) as to have been rejected as a silver ore; and its true character seems to have been either overlooked or mistaken until recently. Samples were sent to England, where the value of the mineral as an ore of pure oxide of antimony was at once recognised. Shortly after that Professor Cox, late of the Indiana survey, made arrangements with the owners to ship the ore for treatment to works he has since erected in Oakland, Cal. There appear to be three systems of veins within an area of about four

square miles. First, the most northerly group, the San Jose, was last winter the most productive in antimony; but it carried no silver. Bodies four feet wide, of almost pure oxide of antimony, were exposed. A schooner load had already been shipped, and large quantities of ore awaited transport. Second, the Santa Margarita group, and, third, the Argentine group. Both the second and third are silver bearing, but the first was richer in antimony than the latter. Later developments make the outlook for antimony in the Argentine as good as in Santa Margarita. A shallow shaft, 20 feet deep, was sinking on the Margarita, which in the bottom exposed a mass of pure oxide of antimony, four feet wide. The ore is of a light yellowish-green colour, irregularly jointed, and breaks with a rough conchoidal fracture. The silver appears to coat the joints only, and not to permeate the mass of the ore, and seems to exist as chloride and iodide. The silver contents are said to be 125 dollars per ton, which is considered to be a very moderate estimate, as on the pile at the mouth of the Santa Margarita shaft it was difficult to find a lump whose joints were not more or less stained with silver, while many were thickly covered. Since then work has gone on actively on all three groups of lodes. On the first the ore bodies have been developed to a depth of 72 feet, on the second to a depth of 70 feet, and on the third to a depth of 118 feet, with no signs as yet of a change in the character of the ore or average size of the ore bodies, which, however, have never exhibited great uniformity in width. Two schooner loads have lately been shipped, and it is estimated that 5,000 tons of ore have been exposed by the superficial explorations recently made. A reference to Mr. Cox's papers on the native oxide of antimony, read before the American Association, will be found in this *Journal*, vol. xxviii., p. 874.

NOTES ON BOOKS.

Lathe-work. By Paul N. Hasluck. London: Crosby Lockwood & Co., 1881.

There is no doubt that many interested in mechanics, especially as amateurs, have found the want of a good practical treatise on the amateur's tool *par excellence*, the lathe. "Holtzapffel" is too costly for everybody, and, besides, the original work stopped short before it reached the lathe. The introductory matter extended itself to such a length that the author had not time before his death to complete the work he had designed. Many other writers have tried to fill the gap, but, without casting any reflection on their efforts, it must be allowed that we are still without such a work as "Mechanical Manipulation" would have been had the elder Holtzapffel lived to finish his work. Of these writers, Mr. Hasluck is the latest, and his book will certainly bear comparison with those of any of his rivals. He seems to owe little to his predecessors, for his book looks like the result of original work and experience, and as such it will doubtless recommend itself not only to amateurs, but to that large and growing class of artisans who are gradually finding out that much of their trade can be learnt from books, and that practice in the workshop is none the less useful if it is accompanied by some of the general knowledge which is given by a suitable text-book. Any writer on the lathe must of necessity arrange his subject in one certain fashion—that is if he intends to deal with the subject generally, and not to treat only, or principally, of a single part of it. He naturally commences with a little history—it is the orthodox thing to do, and it makes a pleasant beginning. Then we expect a description of the lathe; hand-turning in wood and metal lead up in inevitable sequence to the slide-rest, and from this we generally branch off in one direction to what may be termed engineering work, and in the other to ornamental turning, overhead gear, and the various elaborate and wonderful chucks which are the delight of the ornamental turner and the wonder of the ignorant. In the general arrangement of his materials, Mr. Hasluck follows—more or less—the beaten track, except that he deals almost entirely with straightforward work. Ornamental turning comes in for practically no notice at his hand. In an introductory book this is certainly a merit, and all the greater merit because instruction and information in this department of lathe-work is more readily obtained by the amateur than in other branches of the art, while the apprentice or young engineer does not require it, and for him any space so occupied in the book would be space almost, if not entirely, wasted.

GENERAL NOTES.

London Sanitary Protection Association.—The first general meeting of this association will be held in the Society of Arts' Room on Tuesday, the 25th inst., at eight p.m., when Professor Huxley will preside. A report of the work done during the last nine months, since in fact the reading of Professor Fleeming Jenkin's paper before the Society of Arts on January 12th last, will be given by Mr. Jenkin. All members of the Society of Arts are invited to attend the meeting.

Effects of Light on Vegetation.—Herr Stebler has been making experiments lately on this subject, and finds that the germination of certain agricultural grasses, such as meadow grass (*poa*) is much more favoured by light than by heat. An experiment made with two groups, of 400 seeds each, of *Poa nemoralis*, showed that there germinated 62 per cent. in light, and 3 per cent. in darkness. Similar results were made with *Poa pratensis*, showing 59 per cent. germinating in light, and 7 per cent. in darkness. Sun light being a very variable force, experiments were further made with gas light, and with the same result—viz., that light favours the germination of certain seeds, especially grass, and that these germinate either not at all, or very scantily, in darkness. The fact was verified by Herr Stebler in a whole series of seeds, such as *Festuca*, *Cynosurus*, *Alopecurus*, &c. In the case of seeds that germinate quickly and early, such as clover, beans, or peas, Herr Stebler thinks that light is probably not advantageous.

Electric Light Engines.—Messrs. Robey, of Lincoln, show seven stationary engines at the Paris Electrical Exhibition, varying in size from 10 to 40-horse power, which supply the power for the dynamo-electric machines of the Brush Electric Light Company, and are remarkable for their steady action, owing to the adoption of a special automatic "governor." The 40-horse power engine drives about forty arc lights; and, after careful experiments, it is found that the variation from the nominal speed does not exceed one revolution during the evening's work of three hours. But in addition to this power of self-regulation, Messrs. Robey have adopted the expedient of making two or three engines keep each other in check. Three engines are used to drive one length of shafting, the object being that any variation in one engine may be absorbed by the other two, and a regular speed is obtained. If the three engines are running at full speed under their usual load, the work done by any one engine may be doubled by slightly turning a nut on the governor spindle. The speed of the shafting is not, however, increased, but the work done by the other two engines is halved, so that the total power developed remains the same. If, for instance, the three engines are indicating 10-horse power each, then by altering the governor of the centre engine to 20-horse power the other engines are found to indicate only 5-horse power each—the total power remaining the same; so that any slight variation in the speed of one engine, through accident or otherwise, is immediately absorbed by the others.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

THE JOURNAL.

With the commencement of the new volume on November 18, certain alterations will be made in the type used in the *Journal*, which it is hoped will improve its appearance. No change will be made in the size of the pages.

As the regulations of the Post-office now permit newspapers to be stitched without incurring additional charge for postage, it is intended in future to stitch the *Journal*. This alteration, also, will commence with the new volume.

ARRANGEMENTS FOR THE SESSION.

The arrangements for the one hundred and twenty-eighth session of the Society have now been made by the Council, and full particulars will be printed in the next number of the *Journal*.

The first meeting will be held on the 16th November, when the opening address will be delivered by Sir F. J. Bramwell, F.R.S, Chairman of the Council. Previous to Christmas, there will be four ordinary meetings in addition to the opening meeting. Candidates proposed for election as members, are privileged to attend the opening meeting.

There will be four courses of Cantor Lectures during the session. The first course, on "Some of the Industrial uses of the Calcium Compounds," by Thomas Bolas, F.C.S., will be delivered before Christmas.

The two Juvenile Lectures at Christmas will be by W. H. Preece, F.R.S., on "Recent Wonders of Electricity." Announcement of the arrangements for these Lectures will be made in due course.

PATENT LAW.

The evening of Wednesday, November 30, will be devoted to a discussion on the Society of Arts' Patent Bill, which will be continued on such other evenings as may be found convenient. The discussion will be opened by Sir FREDERICK BRAMWELL, F.R.S., Chairman of the Council.

The Secretary will be glad to furnish tickets for the meeting to persons interested in the subject of Patent Law who are not members of the Society.

OWEN JONES PRIZES FOR FURNITURE DESIGNS.

The Council are Trustees of the sum of £400, presented to them by the Owen Jones Memorial Committee, being the balance of the subscriptions to that fund, upon trust to expend the interest thereof in prizes to "Students of the Schools of Art who in annual competition produce the best Designs for Household Furniture, Carpets, Wall-papers and Hangings, Damask, Chintzes, &c., regulated by the principles laid down by Owen Jones;" the prizes to "consist of a bound copy of Owen Jones's 'Principles of Design,' a Bronze Medal, and such sums of money as the fund admits of."

The prizes will be awarded on the results of the Annual Competition of the Science and Art Department. Competing designs must be marked "In competition for the Owen Jones Prizes."

The next award will be made in 1882, when six prizes are offered for competition, each prize to consist of a bound copy of Owen Jones's "Principles of Design," and the Society's Bronze Medal.

PROCEEDINGS OF THE SOCIETY.

EXHIBITION OF WORKS OF ART APPLIED TO FURNITURE, 1881.

The following Report of the judges appointed to recommend awards of silver and bronze medals, offered by the Society of Arts to the Designers and Art Workmen whose work was exhibited in the Exhibition of Works of Art applied to Furniture, held in 1881, at the Royal Albert-hall, has been received by the Council, and been approved by them.

1. The collection of works of Art included many branches of artistic handicraft, such as carving and inlaying in wood, ivory, &c., cabinet work and fine joinery, painting on various materials like wood, glass, and pottery, glass cutting, the process known as *pâte sur pâte*, beating and chasing metals like silver and brass, wrought-iron work, modelled and glazed stoneware, and decorative needlework. The arrangement of the objects had been undertaken by the various exhibiting firms. A definite space had been assigned to each firm, who decorated it with hangings or with painted and gilt moulded work, or wood panelling, &c., and then disposed within it the various objects of furniture, &c. We were much pleased with the general good

taste displayed in the separate divisions and in the aspect of the Exhibition as a whole.

2. In Bay No. 1, occupied by Messrs. Crace and Son, the important cabinet of carved walnut wood was distinguished for its excellence. A number of hands, it was stated, had been employed upon the carving, which called forth our admiration. It was therefore not possible to single out one Art workman to whom a medal might have been awarded. For the same cause no distinction could be awarded in respect of the admirably inlaid octagon table of walnut wood, the design for the ornamental border of which has been made by Mr. J. D. Crace. The painting done upon a cabinet of satin wood, by Mr. Herman Scholz, as well as the daintiness of his rendering of the little figures of boys in the medallions, merit the distinction of a Bronze Medal. In this Bay a tray and set of tea things, in a dark olive-green body, ornamented with applications of well-depicted forms in white paste *(pâte sur pâte)*, exhibited by Messrs. Mintons, and designed and executed by Mons. Solon, we specially commend as worthy of a Silver Medal.

3. The decoration of the side of a room, exhibited by Messrs. Morant, Boyd, and Blanford, remarkable for the excellence and finish of the work, was based upon a scheme good in its proportions, and the blending of the delicate tones of colour adopted, with those of the damask panels, and the details of the ornamental forms used, redound to the good taste of the designer, Mr. V. Barnard. Messrs. Morant, Boyd, and Blanford also exhibit a satin wood cabinet, and we consider that Mr. H. Reich, who inlaid the frieze of interlacing garlands upon the front of the drawer and the central ornament of the flap should be rewarded with a Bronze Medal.

4. Near Bay No. 2 hung three red lustre plates, the work of Mr. W. de Morgan, to whom a Silver Medal should be given for suitability of design to the materials employed, as well as for the fine tones of colour and lustre obtained.

5. In Messrs. Jackson and Graham's cabinet and chimney-piece, of a so-called Oriental Greek character, extraordinarily delicate and perfectly fitting marquetry work, and very finished cabinet-makers' work, attracted attention. A Bronze Medal is due to Mr. A. Reich, the marquetry worker, and a Bronze Medal to Mr. A. Baldwin, cabinet-maker; to Mr. Marchant, who is understood to have assisted in the cabinet work, we award one of the Society's Certificates. Beneath the chimney-piece in rosewood, with plaques of inlay of ivory, ebony, and mother-o'-pearl, designed by Mr. Allwright, was a wrought iron grate, of simple design, in good taste, made by Mr. Sayer, a member of the firm of Messrs. Feetham and Co., who exhibited other grates and fire-irons of good pattern and workmanship. A piece of embroidery, designed by Mrs. Alfred Morrison, who prescribed the colours and selected the materials used, greatly pleased us by the excellent distribution of Oriental motives, as well as the beautiful harmony in colour displayed in it.

6. The walnut seat for a vestibule, understood to be a copy of an old French design, reflects great credit in respect of its workmanship upon the exhibitors, Messrs. Gillow and Co. The carving, by Mr. M. Anderson, of the pendent heads of the canopy, and scroll-work on the arms of the seat, is well done. Carving in satin wood of garlands, on a small scale, but in high relief, and also of medallions, with a layer of satin wood upon a ground of ebony, in imitation of cameo cutting, executed by Mr. Ross, to decorate the satin wood cabinet, made for the Empress of Russia by Messrs. Gillow, showed much skill in the execution, but in a direction of doubtful taste.

7. The carving of panels of boxwood let into a rosewood cabinet exhibited by Messrs. Holland and Sons, was commendable.

8. In Bay No. 6, some lightly constructed furniture, including a stand in dark wood, after a Japanese model, and some chairs after good models of the Chippendale and Sheraton period, shown by Messrs. Howard and Co., was particularly noticeable for its gracefully designed and well-cut ornamental details. A rosewood chimney-piece showed good cabinet-maker's work. The designer of these pieces is Mr. Randal, whom we select for an award of a Bronze Medal, as well as for his design for a white metal fire-place and fittings. Some extraordinary specimens of glass cutting and engraving, by Mr. Northwood, who has produced a very remarkable *fac-simile* of the "Portland vase," probably unique as a work of glass-cutting of modern times; and a vase, called the "Milton vase," designed by Mr. Pargeter, of the Red-house Glass-works, were exhibited by Mr. Pargeter. To the glass engraver, Mr. Northwood, we award a Silver Medal.

9. Messrs. Wright and Mansfield contributed several excellent examples of inlaid work of the English 18th century style, in the manner of Chippendale, Adam, and Sheraton, as well as work, enamelled and decorated in the style of designs by Pergolesi. Awards of Bronze Medals were made to Mr. Thomas Hinton, the foreman workman, and to Mr. Victor Reich, the marquetry worker, and of Certificates to Messrs. Samuel Bryne, Charles Humphreys, and Thomas Miller, cabinet-makers, by whom the more important of these works were produced. The carved and gilt mirror frames and girandoles in the style of the 18th century English, and of Louis XV. French periods, especially three placed over the sideboard, were noted for superior workmanship, the carving being done by Mr. John R. Wingfield.

10. The modelling of the relief ornament carved by many hands, in a deep red mahogany mantel-piece and cabinet exhibited by Messrs. Collinson and Lock, was particularly good, and we award a Silver Medal to Mr. Webb, the modeller, for this and for many other specimens exhibited. His design for metal sconces was distinguished for richness in arrangement of conventional foliage, well-grouped, and modelled with good effect of low relief and harmony in flowing lines. The metal worker who wrought this design in brass is Mr. Singer, to whom we award a Bronze Medal. Of a different style, but of much excellence, the design being by Mr. Lock, the modelling by Mr. Webb, and the actual metal work by Mr. G. Price, was a mirror frame of *repoussé* oxydised silver. We award a Bronze Medal to Mr. G. Price for his metal working. The whole of the collection of furniture exhibited by Messrs. Collinson and Lock was noticeable for the completeness of workmanship throughout.

11. Some wrought iron by Mr. Sidney Phelps, of Sidney Sussex College, Cambridge, deserves mention, especially the panel for a balcony, which was

of a good style of design, with interlacements of rod iron and beaten leaves of plate iron. The figures in the small panels, of deep modelled relief in terra-cotta, designed and executed by Mr. G. Tinworth, are full of expressive action, and we consider that a Certificate should be awarded to this artist. We award a second Certificate to Mr. G. Tinworth, the designer of the large flattened, circular bowl, executed in stoneware, and shown by Messrs. Doulton; and a Certificate to Mr. Edward Sears, for his careful and clean painting in monochrome on two tiles, called respectively "A Saucy Companion" and "An Odd Chicken." We desire to commend the skill displayed in two delicately-carved birds in lime-wood, the work of Mr. W. Perry. Two panels of painted glass, suitable for the decoration of a house or hall, representing "Art" and "Science," appeared to us to show a right appreciation of the application of coloured design to glass, without detracting from its utility as a window through which light has to pass.

12. In Bay No. 9, containing articles exhibited by Messrs. Gregory and Co., the reproduction of an old English arm-chair, enriched with carved and turned rails, and a little tea-table, were highly finished in workmanship, and commendable for the lightness of their construction. We award a Bronze Medal to Mr. W. P. Collins, the designer of these articles. To the designer, Mr. T. W. Hay, of the woven hanging, for the drawing and arrangement of details, as well as for good harmony of colour, we propose to award a Certificate.

13. The well-proportioned framework or walnut panelling, for the side of dining-room or hall, shown by Messrs. Johnstone, Jeanes and Co, in Bay No. 11, was excellent in design, but, in our opinion, the effect would have been better if simple wood panelling instead of tapestry had been used. As it was it produced the impression of an open screen which had been filled up, rather than of a wall.

14. The carving of the students of the School of Wood Carving, South Kensington Museum, was meritorious; and the pilaster executed by Miss Eleanor Rowe, of this school, showed good feeling for flow of line and the modelling of surfaces. It may be well to mention here that a principal aim of this school is to cultivate the production of wood-carving in a broad style, and at a cheap rate, similar to that used so largely for decorative purposes in the 18th century in this country. The works of this school are not, therefore, intended to compete with more expensive and more highly finished wood-carvings.

15. We award a Silver Medal to Mr. R. Gleeson, for the suitable and graceful fan-mounts, which he has designed and executed, especially that of ivory, mounted with Mechlin lace. The inlaid amboyna wood table, the work of Mr. Thomas Jacob, gained the distinction of a Bronze Medal, for the beauty of the marquetry work.

16. In concluding our report upon this Exhibition, we are of opinion that annual Exhibitions, at which are shown various classes of Fine Art Applied to Industry, such as those represented at the present Exhibition, might be usefully supplemented were designers for all sorts of handicrafts and manufactures to be encouraged to submit drawings and sketches of designs which *have actually been carried out.* A section was allotted for such drawings at the Paris Exhibition of 1878; and, in our opinion, much useful instruction and information might be gained from such an annual display of designs to the benefit of producers and consumers.

GEORGE GODWIN (F.R.S.).
MONTAGUE GUEST (M.P.).
EDWARD J. POYNTER (R.A.).
ALAN S. COLE (Hon. Secretary).

5th August, 1881.

The Viscount Hardinge wrote to express his regret at being prevented from attending the meeting.

LIST OF AWARDS.

SILVER MEDALS.

- Mons. Solon, for olive green tea service, *pâte sur pâte* (Messrs. Minton).
- Mr. de Morgan, lustre plates.
- Mr. Webb, modeller and designer (Messrs. Collinson and Lock).
- Mr. R. Gleeson, for carved fan mounts.
- Mr. Northwood, for glass cutting and engraving (Mr. Pargeter).

BRONZE MEDALS.

- Mr. H. Scholz, for painted furniture (Messrs. J. G. Crace and Son).
- Mr. Vernon Barnard, designer of side of room (Messrs. Morant, Boyd, and Blanford).
- Mr. J. R. Randal, furniture designs and design for fender (Messrs. Howard and Co.).
- Mr. Albert Reich, marquetry worker (Messrs. Jackson and Graham).
- Mr. H. Reich, marquetry worker of cabinet (Messrs. Morant, Boyd, and Blanford).
- Mr. William Allwright, designer of rosewood chimney-piece, inlaid with ivory, ebony, mother-o'-pearl (Messrs. Jackson and Graham).
- Mr. Baldwin, cabinet-maker (Messrs. Jackson and Graham).
- Mr. T. Hinton, foreman cabinet-maker (Messrs. Wright and Mansfield).
- Mr. Victor Reich, marquetry worker (Messrs. Wright and Mansfield).
- Mr. Singer, for beaten brass-work (Messrs. Collinson and Lock).
- Mr. G. Price, for beaten oxydised silver frame (Messrs. Collinson and Lock).
- Mr. W. P. Collins, designs for furniture (Messrs. Gregory and Co.).
- Mr. T. Jacob, for marquetry top to table.

CERTIFICATES.

- Mr. Marchant, cabinet maker (Messrs. Jackson and Graham).
- Mr. C. Humphreys, cabinet-maker (Messrs. Wright and Mansfield).
- Mr. T. Miller ,, ,,
- Mr. S. Bryne ,, ,,
- Mr. M. Anderson, carver (Messrs. Gillows).
- Mr. T. W. Hay, designer of woven silken fabric for room decoration (Messrs. Gregory and Co.).
- Mr. G. Tinworth, terra-cotta panels.
- Mr. G. Tinworth, designer and modeller of flattened round bowl, shown by Messrs. Doulton.
- Mr. Edward Sears, for painted tiles.
- Miss Eleanor Rowe, for carved wood pilaster.
- Mr. W. Perry, for carving in wood.
- Mr. Sidney Phelps, wrought-iron work.
- Mr. W. C. Codman, designer of panelling (Messrs. Johnstone and Jeanes).

MEDALS OF THE SOCIETY OF ARTS.

The Society of Arts grew out of a suggestion made by William Shipley, a drawing master of Northampton, and brother of Jonathan Shipley, a well-known Bishop of St. Asaph. Shipley issued on June 8th, 1753, "Proposals for raising by subscription a fund to be distributed in premiums for the promoting of improvements in the Liberal Arts and Sciences, Manufactures, &c;" and in December of the same year he published "a scheme for putting the proposals into execution." The Society was formed in 1754, at a meeting held on 22nd of March at Rawthmell's coffee-house in Henrietta-street, Covent-garden. Premiums were at once offered for the discovery of cobalt and the growth of madder in this country, and for proficiency in drawing. With these offers the Society commenced its prosperous career. A proposal to give medals "on some occasions instead of money" was considered at the meeting of April 30th, 1755, but the matter was postponed as no action could be taken that year. Henry Baker, F.R.S., read a paper on March, 24th, 1756, proposing the distribution of medals as honorary premiums, in which he said—

"It is therefore proposed that a dye be made for striking medals of gold, silver, and copper (with proper devices), to be occasionally bestowed by the Society as a token of honour and esteem on such as shall practice or produce some new manufacture or discovery that may employ many hands, some considerable improvement of public utility, or some valuable branch of commerce in one or the other metal, according to the nature and consequence of the improvement or discovery; which medals in gold shall be of £5 value, and proportionately in silver and copper, though, in all of them, the honour of being thus distinguished is the principal object of regard."

This paper was referred to a committee for consideration on March 31st. The committee reported on April 7th that they were of opinion that the giving of medals would be of utility, and they suggested that a committee should be appointed to consider a proper device. Subsequently Mr. Baker submitted a sketch of a design, as did Nicholas Crisp and Mr. Ralph. Hogarth, Henry Cheere, and Nicholas Highmore were upon the medal committee, who agreed upon a device, and afterwards James Stuart, William Chambers, and Thomas Hollis, were added to the committee. After the design had beeu chased upon gold plates, and the order given for the dies to be cut, a difficulty arose. It was decided on March 23, 1757, that the value of the medal should not exceed ten guineas, but when specimens of the selected design were produced it was found that the die could not be carried out completely if less than 15 guineas' worth of gold was used. This was considered too much, and the report of the committee was referred back to them, with instructions to obtain a new device which should only need gold to the amount of five guineas. If, however, the device in hand could be executed for the proposed five guineas, this was to be preferred. On May, 24th, 1758, Mr. Yeo produced two gold medals, struck from the die which he had cast, the value of one being ten guineas, that of the other, £8 10s. This was not considered satisfactory, and the committee to whom the matter was referred declined to make a report. The general meeting of the Society discussed the point on June 7, and resolved:—

"That it is the opinion of this Society that the said medal does not, both in execution and expense, answer the interest and expectation of the Society."

It was further resolved that dies and puncheons should be cut for a new medal, according to the designs of Mr. Stuart, the value in gold not to be less than five, nor to exceed eight guineas, pursuant to a former resolution. Mr. Stuart was now asked to appoint his own artist, and he chose Thomas Pingo, the famous die sinker, who agreed to cut dies and puncheons for eighty guineas. The work was quite satisfactory, but in November Pingo found that he could not buy gold and silver without a licence, and Mr. Pinchbeck (a rather ominous name, considering the metal associated with his name) was desired to furnish Mr. Pingo with gold and silver for the purpose. At last the Society obtained what they had so long been striving for—a thoroughly good medal, at a reasonable cost. On November 29, the thanks of the Society were unanimously given to Mr. Stuart, and a gold medal was ordered to be presented to him, for the great care and trouble he had taken in this matter. On December 6, it was ordered:—

"That the inscriptions on the first gold medal, which is to be presented to Lord Viscount Folkestone, President of this Society, be forthwith engraved, as follows (in pursuance of the resolution of the 24th of May last):—On the reverse, without the wreath of olive, To Jacob, Viscount Folkestone, President; and within the wreath of olive, For Eminent Services."

Inscriptions for other gold medals were ordered at the same meeting. To Lord Romney, for eminent services; to Lady Augusta Greville, for drawing, 1757; to the Duke of Beaufort, Philip Carteret Webb, F.R.S., and John Berney—all for sowing acorns, 1757; and to James Stuart, painter and architect, "for designing this medal." The obverse of the medal is shown in the annexed figure.

First Medal of the Society.

There was much discussion in the Society respecting the inscription on the obverse of this medal. Thus in May, 1857, it was decided that the legend should be "Arts and Commerce Promoted" instead of "Arts, Manufactures, and Commerce Promoted." In November it was changed to "Society for Promoting Arts and Commerce," and later on the inscription as first proposed was adopted. In the earlier draft the date of institution was set down

as 1753, but afterwards it was fixed for the year 1754.

This medal was largely used for nearly half a century, but in 1801, James Barry took occasion in his account of his additions to the pictures in the great room, to suggest an improvement in the design. He wrote:—

"Mr. Barry begs leave to add, from a letter read by him to the Society, Ooctober 25th, 1801, that in consequence of the application for designs for a new die for their medal, he stated his intention of introducing a modification of their former design, which he thought would answer their intended purpose. The more the subject matter of that design is considered, the more one must admire and respect the sterling good sense and weighty consideration of the original founders of the Society. Nothing can be more happily imagined than the idea consisting of Britannia aided by Minerva and Mercury, the classical tutelary deities of Arts, Manufactures, and Commerce; and this old device, like many other good old usages, cannot be amended by any change in the substratum. It requires nothing more in its essence, and will most happily coalesce and accommodate with all the acquisitions and improvements of the most enlarged and refined culture. For this purpose a little more *goût* and character in the figures is all that is necessary, enlarging them so as to fill the space with more dignity, and taking away from their individual scattered appearance by the little graces and arts of a more improved composition. And as there is always a considerable dignity and consequence attached to magnitude which is one of the constituents of sublimity, his suggested alterations would come to this—to substitute instead of the little entire figures of Minerva and Mercury, only two large heads of those deities, and he would omit the head of Britannia altogether, and by a wreath of the shamrock, rose, and thistle, totally rising round the edge of the medal, playing in and out in a graceful gustoso manner, he would represent the present happily United Kingdom of Great Britain and Ireland, with a felicity, at least, equal to the owl, the horse's head, or the dolphin on the Athenian, Punice, or Sicilian coins."*

This full description of Barry's views is interesting, as showing how completely they were carried out in the new medal. In 1802, a totally different design was discussed. Application was made to Mr. Marchant, Associate of the Royal Academy, and gem engraver, to prepare a die, and the Committee of Polite Arts recommended "The Society to be personified by a female, seated, having in one hand a wreath of laurel, and with the other directing attention to the statues of Minerva, Mercury, and Ceres, the ancient deities presiding over the Liberal arts—commerce and agriculture—the immediate objects of the Society." The obverse of the medal to be the head of the President, with the date of his election, and the value of the gold to be twelve guineas. Mr. Marchant, into whose hands the work was placed, appears to have been very dilatory, and after many inquiries it was decided, in April, 1805, to order him "to suspend proceedings with the dies until he hears from the Society." The Committee of Polite Arts then declared that it was expedient to resume the deliberation as to the design *ab initio*; and they recommended the Society "That Messrs. Papworth, Flaxman, Howard, Barry, and Tresham be severally applied to, professionally, to furnish rough sketches and designs for the intended medal."

* Transactions—Vol. 19, pp. xxxvi—xxxix.

At a meeting of the Society, on the 4th December, 1805, a report of the Committee, recommending that Mr. Flaxman be desired to furnish a design, on the principle suggested by Mr. Barry, was read, when Barry made a motion to the effect that the report should be recommitted, but his motion was not agreed to. The next meeting, on the 11th of December, was apparently a stormy one, for a series of motions were brought forward, most of which were "disagreed to." At last, Mr. Wakefield made the definite proposition that "the name of Flaxman be erased, and that of Barry inserted;" but this did not find favour with the meeting, and eventually the original resolution of the committee was agreed to. Barry died in the following year, and then there was no obstacle to the completion of Flaxman's medal. Mr. Pidgeon prepared the dies, and in November, 1806, Flaxman expressed himself as highly pleased with the excellence of the execution. The Society were so

Medal designed by Flaxman.

pleased with the new medal, that they desired to have an engraving of it for publication in the Transactions. Flaxman proposed that his sister-in-law, Miss Denman, should make the drawing,

Another form of the Minerva medal.

and that the famous Anker Smith should engrave it. The engraving thus produced forms a frontispiece to the 25th volume of the Transactions. Among the medals presented in 1807 were these two:—

J. Flaxman, Esq., R.A., Buckingham-place, for

the design of the Society's new medal, modelled and presented by him—the first gold medal.

Miss Maria Denman, for her drawing of the new medal, the silver medal.

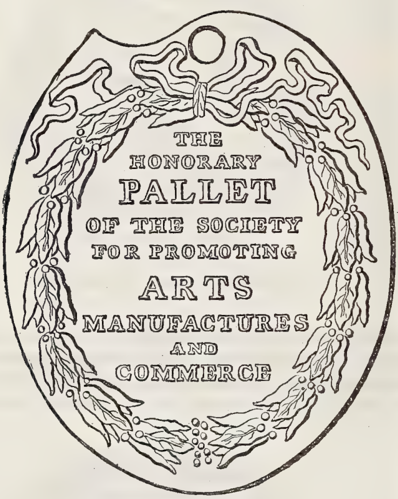
In 1818, it was found that the die for the Minerva medal was worn out, and Mr. Wyon offered to make a new one from Flaxman's original model, and to present it, in consideration of the liberal treatment he had always received from the Society. The thanks of the Society were voted to Wyon "for his very handsome offer" at the meeting on June 10th.

A case of fraud in the use of one of the medals came under the notice of the Society in the year 1813, which was summarily dealt with. The Minerva medal was given to an inventor "for his safe and economical fire of wood shavings," and the man engraved a representation of the medal on his business card, with the statement that the Society had presented it to him "for his invention of a superior method of preparing his materials for the manufacturing of pianofortes, organs, and other musical instruments." On being called upon for an explanation, the pianoforte maker tried unsuccessfully to excuse his action, and, on demand, he gave up the copper-plate of his cards. It was resolved by the Society that this should be destroyed, and all impressions from it burnt, with the exception of two to be placed on the minutes. At the meeting of May 26th—

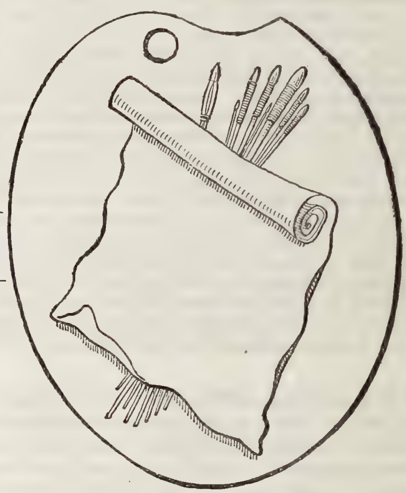
"The Society deeming it proper to have the plate and tickets destroyed without loss of time, an order was given from the chair to that purpose, and they were burnt in the presence of the members."

Honorary Pallet.

For a few years after the formation of the Society the only honorary reward was Stuart's medal, but about the year 1766 it was thought expedient to adopt some honorary premium in place of pecuniary rewards for such successful candidates in the different Sections (more particularly that of Polite Arts) who were under age. At a meeting of the Com-



Obverse of Pallet.



Reverse of Pallet.

mittee of Polite Arts on January 28, 1766, it was resolved :—

"That these honorary premiums shall be pieces of wrought silver-plate, useful in, or allusive to, the particular art or branch of art in which the candidate claims (as drawing boxes, emblematical pallets, &c.), bearing an inscription exhibiting the name and age of the candidate, and the class and degree of premiums, &c., for which the same is given."

It was subsequently resolved that the pallet should be of an oval figure, $2\frac{1}{2}$ inches by 2, of the thickness of half-a crown. On March 21, two drawings which had been presented were considered, and one of them chosen. The die was to cost twenty guineas, and Mr. Johnson was desired to execute it.

There was a great silver pallet and a small one, and also in a few cases a gold pallet was awarded. The first award of the silver pallet was in 1767.

Isis Medal.

The Society has always been greatly interested in the improvement of the art of die-sinking, and at various times has offered preminms for this purpose. In 1809, Mr. T. Wyon, Jun., appeared as a claimant for one of these, and produced the

Isis Medal.

dies for a medal of Isis, which was highly approved, and in the list of awards for the year 1810 we find the following entry :—

"To Mr. T. Wyon, Jun., John-street, Blackfriars, for a medal die engraving of a beautiful head of Isis, the patroness of the arts, the gold medal."

At a meeting of the Society on April 4th, 1811, it was resolved that this medal should be substituted for the greater silver pallet, as a reward in the department of Polite Arts. But at a subsequent meeting it was agreed that the change should be made at the option of the candidates, and therefore we find in the lists of awards for 1811 that both pallets and Isis medals were given. Later on, the Isis medal became the favourite medal of the Society, and was largely given in the various classes up to quite a late period.

Ceres Medal.

In 1813, the Society's gold medal was given to Mr. William Wyon, of Birmingham, for a medal die engraving of the head of Ceres; and at the meeting

Ceres Medal.

of June 2nd of this same year, the advisability of purchasing this medal for the purpose of award in the department of agriculture was considered. In 1814, gold and silver Ceres medals were awarded for improvements in agriculture.

Vulcan Medal.

In 1818, Mr. Mills produced a medal die of the head of Vulcan, which was approved by the Society,

Vulcan Medal.

who agreed that it should be purchased, and used as a second medal for the department of mechanics, provided the cost did not exceed twenty guineas, the sum paid for the Isis medal. Gold and silver Vulcan medals were given for the first time for improvements in mechanics in the year 1820.

Society's Medal.

In 1849, the dies of the Minerva medal were found to be worn out, and it therefore became necessary to take some steps for the preparation of a new one. Mr. (now Sir Henry) Cole suggested "That it would be desirable, if possible, to obtain permission to use the H.R.H. Prince Albert's medal dies for the Society, such dies being portraits of His Royal Highness, the Society's President." And he reported to the Council in April of that year that he had been informed by Colonel Phipps that His Royal Highness approved of the suggestion. In August, 1849, it was resolved by the Council—

"That instructions be given to Mr. Wyon to proceed forthwith in the preparation of the new larger die, with an impression of the head of H.R.H. Prince Albert, presented by His Royal Highness."

Society's Medal 1849-1861.

At the election of His Royal Highness the Prince of Wales to the Presidentship, in 1863, his head was placed upon the obverse of the medal. At the same time the reverse was re-engraved; the wreath and inscription remained the same, but the engraving was bolder, and more artistic than that on the old medal.

Albert Medal.

The highest honour in the gift of the Society is the Albert medal, which was founded in memory of H.R.H. the Prince Consort, who was for eighteen years President of the Society. On the 4th February, 1863, the Council resolved :—

"That a gold medal, to be called the Albert medal, be provided by the Society, to be awarded by the Council not oftener than once a year, for distinguished merit in promoting Arts, Manufactures, or Commerce."

It was subsequently resolved that Mr. Leonard Wyon be requested to furnish the model for a head of the Prince at a late period of his life, the inscription to be "Albert, Prince Consort." It was decided that the reverse should be illustrative of Arts, Manufactures, and Commerce, and that several well-known artists should be invited to furnish designs. Ultimately, Mr. Leonard Wyon produced a design, which was accepted, and he then proceeded to prepare the dies. The first award of the Albert medal was in 1863, to Sir Rowland Hill: "For his great services to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have extended over the civilised world."

Albert Medal.

Society's Medal from 1863 to the present time.

MISCELLANEOUS.

WHEAT CROP OF 1881.

The following calculations on this subject by Mr. J. B. Lawes, F.R.S., of Rothamsted are taken from the *Gardener's Chronicle*:—

"The seven seasons ending with 1881 have been more disastrous to British agriculture than any seven consecutive years of which we have a record. Those who hold the opinion that the fluctuations of the weather occur in definite cycles, will have some difficulty in finding a parallel to the period of the last seven years, without going back to very remote records. The change in the relative proportions of home-produced and imported wheat which has taken place during the last few years has entirely altered the character of the trade. In 1868-9, two-thirds of the total bread consumed was the produce of home-grown wheat. A few years later the requirements of the country were met by one-half of home-grown and one-half of foreign wheat. But the harvest of 1879 scarcely supplied one loaf in four required, that of 1880 only one in three, and that of 1881 will also supply only about one loaf in three required. We cannot ignore the fact that, in consequence of these great changes, the question of a good or bad wheat crop, however important it may be to the landowner or the cultivator, is no longer of the same importance to the nation at large as it was formerly. Another point worthy of notice is that, although our requirements for foreign wheat are becoming larger and larger, the fluctuations in the amonnts required from year to year are becoming much less. Thus, after the bad season of 1860, the nett imports of wheat increased from 4½ to 10 million quarters, or by more than 100 per cent. In 1872-3 the imports were 3,000,000 quarters more than in the previous year, corresponding to an increase of about 33 per cent. But after the harvest of 1879, the worst on record, when the nett imports of wheat increased from 14·1 to 16·4 million quarters, the increase only amounted to about 16 per cent. During the year ending August 31, 1881, the amount of foreign wheat retained for home consumption was more than sixteen million quarters. As the area under wheat in the United Kingdom was last year rather less than 3,000,000 acres, a deficiency of half a quarter per acre in the yield of the crop, although a very serious matter so far as the interests of the cultivator are concerned, has comparatively little influence on the requirements of the country at large for foreign wheat. I have no doubt that my estimate of the home wheat crop of 1880 was

considerably too high. The average of the usually selected plots in my experimental wheat field showed a produce of 27 bushels, reckoned at 61 lb. per bushel. There was at that time sufficient evidence to show how exceedingly bad was the yield of the crop upon the lighter soils; nor can I now account for the fact that in that year wheat grown continuously was so much better than wheat grown in rotation. For example: in the experimental field of light soil at Woburn the land growing wheat every year showed but little difference between the crops in 1879 and 1880; but where, in the same field, wheat was grown in an ordinary four-course rotation, after clover fed off by stock with cake or corn, or without cake or corn, but an application of artificial manures, the produce of 1880 was from 11 to 16 bushels per acre less than under the same treatment in the very bad season of 1879! In the following table is given the produce in 1881, upon the same selected plots as usual, in the field at Rothamsted, which has now grown wheat for thirty-eight years in succession. There is also given for comparison the average produce on the same selected plots—over the last ten years, 1871-1880, over the preceding nineteen years, 1852-1870, and over the total period of twenty-nine years, 1852-1880, during which time the same manures have, in every case, been annually applied to the same plots:—

Harvests.	Unmanured. Plot 3.	Farmyard Manure. Plot 2.	Artificial Manures. Plot 7.	Plot 8.	Plot 9.	Means of Plots 7, 8, 9.	Means, of Plots 1, 2 and 7, 8, 9.
BUSHELS OF DRESSED CORN PER ACRE.							
1881	$13\frac{3}{4}$	$30\frac{1}{4}$	$26\frac{5}{8}$	$30\frac{5}{8}$	$35\frac{1}{2}$	$30\frac{7}{8}$	25
Average 10 years, 1871-80	$9\frac{3}{4}$	$29\frac{3}{4}$	$26\frac{1}{2}$	$30\frac{7}{8}$	$34\frac{5}{8}$	$30\frac{3}{4}$	$23\frac{3}{8}$
Average 19 years, 1852-70	$14\frac{3}{4}$	$35\frac{3}{4}$	36	$38\frac{3}{4}$	37	$37\frac{1}{4}$	$29\frac{1}{4}$
Average 29 years, 1852-80	$13\frac{1}{8}$	$33\frac{5}{8}$	$32\frac{3}{4}$	$36\frac{1}{8}$	$36\frac{1}{4}$	35	$27\frac{1}{4}$
WEIGHT PER BUSHEL OF DRESSED CORN IN POUNDS.							
1881	58·0	58·9	58·8	59·1	58·4	58·8	58·6
Average 10 years, 1871-80	57·5	59·9	59·3	59·1	58·8	59·0	58·8
Average 19 years, 1852-70	58·2	60·0	59·4	59·1	58·4	59·0	59·1
Average 29 years, 1852-80	58·0	60·0	59·4	59·1	58·5	59·0	59·0
TOTAL STRAW, CHAFF, &c., PER ACRE IN CWTS.							
1881	$10\frac{1}{4}$	$21\frac{1}{8}$	$19\frac{5}{8}$	26	$32\frac{1}{2}$	26	$19\frac{1}{8}$
Average 10 years, 1871-80	$8\frac{1}{2}$	$29\frac{7}{8}$	$29\frac{1}{2}$	$37\frac{1}{2}$	$41\frac{7}{8}$	$36\frac{1}{4}$	$24\frac{7}{8}$
Average 19 years, 1852-1870	$13\frac{1}{8}$	$33\frac{5}{8}$	$35\frac{3}{4}$	$41\frac{5}{8}$	$41\frac{5}{8}$	$39\frac{5}{8}$	$28\frac{5}{8}$
Average 29 years, 1852-80	$11\frac{1}{3}$	$32\frac{1}{4}$	$33\frac{1}{2}$	$40\frac{1}{4}$	$41\frac{1}{2}$	$38\frac{3}{8}$	$27\frac{3}{8}$

These figures do not show much prospect of an abundant harvest. The yield per acre is low and the quality indifferent. In no case among the nearly forty plots in the experimental field does the weight per bushel reach 60 lb.; and the produce of straw is at the same time exceedingly low. In an adjoining field twenty-one varieties of wheat were grown side by side; not long before harvest the crops presented an exceedingly luxuriant appearance, and it was considered that the yield would be from 50 to 62 bushels per acre. The result of the threshing is, however, disappointing. The highest produce in the field is only 54 bushels per acre, with a weight per bushel of $57\frac{1}{2}$ lb.; and the lowest produce is, in two cases, $39\frac{1}{2}$ bushels—in one with a weight of 61 lb., and in the other of scarcely 59 lb. per bushel. It is, I think, quite evident that the yield of the wheat crop will vary very much, not only in different districts, but in the same district, and that in different fields on the same farm. The produce in my experimental field, taking the mean of the same selected plots as for many years past, shows an average of 24 bushels per acre, reckoned at 61 lb. per bush.; and assuming an average crop of wheat to be 28 bushels the crop is 14 per cent. below the average.

According to the returns of the Registrar-General, the population of the United Kingdom was a little below 35,000,000 on June 30, 1881. Making due allowance for the natural increase, the mean population to be fed during the year commencing September, 1, 1881, and ending August 31, 1882, will be 35,280,000. Estimating the consumption at $5\frac{5}{8}$ bushels of wheat per head, the quantity required to feed the population will be a little under 25,000,000 quarters. The area under wheat in the United Kingdom was, during the past harvest year, slightly under 3,000,000 acres. If the yield in my experimental field be taken as a guide, the total wheat crop of the country would not amount to 9,000,000 quarters; and deducting from this the amount required for seed, the quantity of home-produced wheat left available for consumption would be only about 8,000,000 quarters, and we should thus have to depend upon foreign supplies for nearly 17,000,000 quarters. As however, wheat has risen considerably in price, and the potato crop is likely to be abundant, it is probable that our requirements for foreign wheat may be satisfied by an import equal to that which we have received during last the two years, namely, from 16,000,000 to 16,500,000 quarters. With a stationary or decreasing area under wheat, and a rapidly increasing population, it is probable that, before many years are pars, the home produce of wheat will not furnish more than one-fourth of the total amount required.

OPIUM IN CHINA.

In July, 1879, Mr. Robert Hart, Inspector-General of Customs at Peking, sent out a circular to the various Commissioners of Customs in China with a form of return, to be filled in with particulars on the following points:—1. How many catties (one catty = $1\frac{1}{3}$ lb. avoirdupois) of boiled or prepared opium can be got from 100 catties of the drug in the crude or unprepared state. 2. Price of unprepared and prepared opium. 3. Weight of prepared opium smoked daily by (*a*) beginners, (*b*) average smokers, (*c*) heavy smokers. 4. How many pipes, one mace of prepared opium will fill. 5. Price of one mace of prepared opium at the retail shops or smoking rooms. 6. Total of unprepared opium of foreign origin imported at each port. 7. Total quantity of unprepared opium of native origin said to be produced. 8. Presumed length of time (months or years) a man must smoke before the habit takes such hold on him that he cannot give it up. 9. Sum total of charges and taxes to which 100 catties of opium are liable after paying import duty. On obtaining replies to these inquiries, Mr. Hart set himself to answer the question:—How many smokers does the foreign drug supply? with the following results which are taken from his report lately published at Shanghai.

The annual importation of foreign opium may be set down, in round numbers, as 100,000 chests (weighing 100 catties each) or 10,000,000 catties. The raw drug loses about 30 per cent. in weight when boiled down and converted into prepared opium, so that it is 7,000,000 catties only that reach the hands of the retailer. The

catty, as already stated, is equal to about one pound and a third, avoirdupois. It is divided into 16 liang, and the liang is divided into tenths, called mace. The amount, therefore, of prepared opium for the supply of smokers is 120,000,000 mace. After paying import duties and likin taxes, the value of a mace of opium may be put at threepence half-penny. Average smokers consume three mace of prepared opium, and spend about 10¾d. daily. This quantity suffices for from 30 to 40 pipes, *i.e.*, whiffs, or "draws." Taking this calculation, Mr. Hart arrives at the fact that, in round numbers, there are about 1,000,000 smokers of foreign opium. Taking the population of China at 300,000,000, this will give the result, that 3½ in every 1,000 smoke, or, that the practice is indulged in by one-third of one per cent. of the population.

Besides the foreign drug, there is the native product, which is largely used. No trustworthy statistics could be obtained of the amount produced, and the estimates vary so greatly that they can only be set down as guesses. Mr. Hart, however, holds that, as far as is known at present, the sale of the native drug cannot exceed the foreign import in quantity. Putting it at the same amount, we arrive at the fact that there are two million smokers, or two-thirds of one per cent of the population. The native product sells for one half of the price obtained for the foreign drug, and the total amount spent on the opium produced at home and imported from abroad is about £25,000,000 annually. Mr. Hart concludes his report with these words:—"Chinese who have studied the opium question are opposed to a traffic which more or less harms smokers, now numbering, say, over two millions, and annually increasing; at the same time, they admit that opium provides a large revenue, that the expenditure for opium, and liability to the incidence of opium taxation, touch an infinitesimally small per-centage of the population, and that neither the finances of the State, nor the wealth of its people, nor the growth of its population, can be specially damaged by a luxury which only draws from 5d. to 11d. a-piece a day from the pockets of those who indulge in it, and which is indulged in by only two-thirds of one per cent. of the population. They admit all this, but they do not find in either the revenue produced or the statistical demonstration of its per-centage innocuousness, any sufficient reason for welcoming the growth of the trade, or for desisting from the attempt to check the consumption of opium."

CORRESPONDENCE.

TANNING.

I am sure that we are upon the eve of a great change in the mode of tanning leather, and what is more to the point of this letter, viz., the transportation of the raw material, hitherto looked upon as "dried bark" or "dried wood." In the latter case, it has at present to be carefully granulated, or else the tanning substances will not yield to the action of cold water. Extracts are now so much more understood, and thanks to the rising generation having studied in most schools and colleges the rudiments of chemistry, they understand the extraction of substances from raw products, and can watch any change that takes place; with a "Tannometer" or "Tan Tester" at hand, anyone with some evaporating pans could extract rich tanning materials in Australia, in India, or in South America, and get them into almost a solid form, so that they could be shipped home in barrels or cases.

The tanners in this country now find that they can work with these extracts much more expeditiously than they could with the old-fashioned process of bark.

Many of your readers having friends in our Colonies, will render them a great service if they will call their attention to this fact, so that they may not allow this trade to fall into the hands of the Americans, which is now yielding them such enormous profits.

Thos. Christy.

GENERAL NOTES.

Merchant Shipping.—A chart, showing forty-five years' history of merchant shipping, has been issued as a supplement to the *British Trade Journal*. In this chart, the respective total tonnage of British, American, and French sailing vessels and steam-ships are given for each year since 1840, inclusive.

London Sanitary Protection Association.—The first general meeting of this association was held in the great room of the Society of Arts, on Tuesday evening, 25th inst., Prof. Huxley, F.R.S., in the chair. Prof. Fleeming Jenkin, F.R.S., narrated the progress and success of similar associations in Newport, U.S.A., in Wolverhampton, in Bradford, and especially in Edinburgh, and announced that an association was just being formed in Brighton. The Chairman said that this association might be called a co-operative store for the supply of good advice on sanitary matters. The success of this association would be for the general good. Mr. Timothy Holmes, the hon. treasurer, said that the state of finance was satisfactory, for though the income was small, the expenditure was still smaller, leaving a satisfactory balance in hand.

Patent Bill.—At a meeting of the Cleveland "Iron Trade" Foremen's Association, held in Middlesbro', Saturday, October 8th, 1881, a paper, by Sir Frederick J. Bramwell, C.E., on the Society of Arts' proposed Patent Bill, was read by the president, Mr. John M. Oubridge. In the discussion that ensued, an epitome of the Bill itself was read, by Mr. Jeremiah Head (honorary member of the association). The following resolutions were carried unanimously:—Proposed by Mr. Jeremiah Head, and seconded by Mr. J. M. Oubridge, and supported by several other gentlemen; 1st. "That the Cleveland 'Iron Trade' Foremen's Association heartily approves of the Society of Arts' proposed new Patent Bill, and pledges itself to support it by every available means." 2nd. It was proposed by Mr. J. M. Oubridge, and seconded by Mr. Robert Telford, "That Mr. Jeremiah Head be authorised and requested to communicate with Sir Frederick J. Bramwell, in order to obtain his advice as to the best means of carrying out the first resolution."

School Board Drill.—The annual drill competition of the London Board schools, for the challenge banner presented by the Society of Arts, took place on Saturday, 22nd October, in the grounds of Lambeth Palace. About 700 boys from the following seventeen different Board Schools, took part in the contest:—First column—1. Medburn-street, St. Pancras; 2. Thomas-street, Limehouse; 3. Plumstead-road; 4. Tennyson-road, Battersea; 5. Portman-place, Mile-end; 6. Penrose-street, Walworth; 7. Larkhall-lane, Clapham; 8. "D" Street, Queen's-park; 9. Battersea-park-road. Second column—1. London-fields, Hackney; 2. Harper-street, New Kent-road; 3. Bellenden-road, Peckham; 4. Sumner-road, Peckham; 5. Waterloo-street, Hammersmith; Fairfield-road, Bow; 7. Harwood-road, Fulham; 8. Westmoreland-road, Walworth. Each school was represented by forty boys and an instructor. The march past took place before the judges, Mr. Freeman (Vice-Chairman of the Board), Colonel Page, and Mr. John Macgregor (Rob Roy), and the companies drilled separately in different parts of the grounds. After a variety of company movements, the Medburn-street School (St. Pancras) and the Portman-place school (Mile-end) companies were marched to the front, and put to a final test to decide the victory, when the choice fell on the Mile-end boys. The next schools in order of merit were Medburn-street (St. Pancras), Thomas-street (Limehouse), the last winners of the competition, and the Tennyson-road School, Battersea.

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FRIDAY, NOVEMBER 4, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

ELECTRIC LIGHTING IN THEATRES.

Mr. R. D'Oyly Carte, the proprietor of the Savoy Theatre, in the Strand, has kindly made arrangements for Members of the Society, who may wish to do so, to inspect the lighting arrangements of the Savoy Theatre, on the afternoon of Saturday, the 12th of November, at ten minutes before five. Members will be admitted on presentation of their visiting cards. Each member may be accompanied by one friend.

ARRANGEMENTS FOR THE SESSION.

The first meeting of the One Hundred and Twenty-eighth Session of the Society will be held on Wednesday, the 16th inst., when the Opening Address will be delivered by Sir Frederick J. Bramwell, F.R.S., Chairman of the Council. Previous to Christmas, there will be four ordinary meetings in addition to the opening meeting.

Candidates proposed for election as members are privileged to attend the opening meeting.

Ordinary Meetings.

The following arrangements for the Wednesday evenings before Christmas have been made :—

November 16.—Opening Meeting of the Session. Address by Sir Frederick J. Bramwell, F.R.S., Chairman of the Council.

November 23.—"The Storage of Electricity." By Prof. Sylvanus Thompson, D.Sc.

November 30.—Discussion on the Society of Arts' Patent Bill, which will be continued on such other evenings as may be found convenient. The discussion will be opened by Sir Frederick J. Bramwell, F.R.S., Chairman of the Council.

December 7.—"The American System of Heating Towns by Steam." By Capt. Douglas Galton, C.B., F.R.S.

December 14.—"Electric Lighting at the Paris Electrical Exhibition." By W. H. Preece, F.R.S.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock :—

January 31; February 28; March 21; April 4, 25; May 23.

Applied Chemistry and Physics Section.

The meetings of this Section will take place on the following Thursday Evenings, at Eight o'clock :—

January 26; February 23; March 9, 30; April 27; May 11.

Indian Section.

The meetings of this Section will take place on the following Friday Evenings, at Eight o'clock :—

February 17; March 17, 31; April 21; May 12, 26.

Cantor Lectures.

The First Course will be on "Some of the Industrial Uses of the Calcium Compounds." By Thomas Bolas, F.C.S.

November 21, 28; December 5, 12.

The Second Course will be on "Recent Advances in Photography." By Capt. Abney, R.E., F.R.S.

January 30; February 6, 13, 20.

The Third Course will be on "Hydraulic Machinery." By Prof. John Perry.

March 6, 13, 20, 27.

The Fourth Course will be on "Book Illustration, Old and New." By J. Comyns Carr.

April 20; May 1, 8, 15.

Juvenile Lectures.

The two Juvenile Lectures will be by W. H. Preece, F.R.S., on "Recent Wonders of Electricity." The dates for these are Wednesday evenings, December 28 and January 4. A full programme of the Sessional Arrangements will be given in next week's *Journal*.

SOCIETY OF SCIENCE, LETTERS, AND ART.

It having come to the knowledge of the Secretary that circulars, purporting to be issued by "The Society of Science, Letters, and Art, of London," or some similar title, and dated from Finsbury-park or Upper Tollington-park, have been sent to certain Members of the Society of Arts, inviting them to subscribe to the "Society of Science, Letters, and Art," and that several subscriptions have been paid to the secretary of the above institution, under the impression that it was connected with the Society of Arts, he is desired to give notice that nothing whatever is known of such a society at this office, and that it is not associated in any way with the Society of Arts.

SOME OF THE DEVELOPMENTS OF MECHANICAL ENGINEERING DURING THE LAST HALF-CENTURY.*

By Sir Frederick Bramwell, V.P. Inst. C.E., F.R.S.
Chairman of the Council of the Society of Arts.

I am quite sure the Section will agree with me in thinking, it was very fortunate for us, and for science generally, that our President refrained from occupying the time of the Section by a retrospect, and devoted himself, in that lucid and clear address with which he favoured us, to the consideration of certain scientific matters connected with engineering, and to the foreshadowing of the directions in which he believes it possible that further improvements may be sought for. But I think it is desirable that some one should give to this Section a record, even although it must be but a brief and an imperfect one, of certain of the improvements that have been made, and of some of the progress that has taken place, during the last fifty years, in the practical application of mechanical science, with which science and its applications our Section is particularly connected. I regret to say that, like most of the gentlemen who sat on this platform yesterday, who, I think, were, without exception, past presidents of the Section, I am old enough to give this record from personal experience. Fifty years ago, I had not the honour of being a member, nor should I, it is true, have been eligible for membership of the Association; but I was at that time vigorously making models of steam-engines, to the great annoyance of the household in which I lived, and was looking forward to the day when I should be old enough to be apprenticed to an engineer. Without further preface, I will briefly allude to some of the principal developments of a few of the branches of engineering. I am well aware that many branches will be left unnoticed; but I trust that the omissions I may make will be remedied by those present who may speak upon the subject after me.

I will begin by alluding to the *Steam-engine employed for manufacturing purposes.* In 1831, the steam-engine for these purposes was commonly the condensing beam engine, and was supplied with steam from boilers, known, from their shape, as waggon boilers; this shape appears to have been chosen rather for the convenience of the sweeps, who periodically went through the flues to remove the soot consequent on the imperfect combustion, than for the purpose of withstanding any internal pressure of steam. The necessary consequence was, that the manufacturing engines of those days were compelled to work with steam of from only $3\frac{1}{2}$ lbs. to 5 lbs. per square inch of pressure above atmosphere. The piston speed rarely exceeded 250 feet per minute, and as a result of the feeble pressure, and of the low rate of speed, very large cylinders indeed were needed relatively to the power obtained. The consumption of fuel was heavy, being commonly from 7 lbs. to 10 lbs. per gross indicated horse-power per hour. The governing of the engine was done by pendulum governors, revolving slowly, and not calculated to exert any greater effort than that of raising the balls at the end of the pendulum arms, thus being, as will be readily seen, very inefficient regulators. The connection of the parts of the engine between themselves was derived from the foundation upon which the engine was supported. Incident to the low piston speed, was slowness of revolution, rendering necessary heavy fly-wheels, to obtain even an approach to practical uniformity of rotation, and frequently rendering necessary also heavy trains of toothed graining, to bring up the speed from that of the revolutions of the engine to that of the machinery it was intended to drive.

In 1881, the boilers are almost invariably cylindrical, and are very commonly internally fired, either by one flue or by two; we owe it to the late Sir William Fairbairn, President of the British Association in 1861, that the danger, which at one time existed, of the collapse of these fire flues, has been entirely removed by his application of circumferential bands. Now-a-days there are, as we know, modifications of Sir William Fairbairn's bands, but by means of his bands, or by modifications thereof, all internally flued boilers are so strengthened, that the risk of a collapse of the flue is at an end. Boilers of this kind are well calculated to furnish—and commonly do furnish—steam of from 40 lb. to 80 lb. pressure above atmosphere. The piston speed is now very generally 400 feet or more, so that, notwithstanding that there is usually a liberal expansion, the mean pressure upon the piston is increased, and this, coupled with its increased speed, enables much more power to be obtained from a given size of cylinder than was formerly obtainable. The revolutions of the engine now are as many as from 60 to 200 per minute, and thus, with far lighter fly-wheels, uniformity of rotation is much more nearly attained. Moreover, all the parts of the engine are self-contained; they no longer depend upon the foundation, and in many cases the condensing is effected either by surface condensers, or, where there is not sufficient water, the condensation is, in a few instances, effected by the evaporative condenser—a condenser which, I am sorry to say, is not generally known, and is therefore but seldom used, although its existence has been nearly as long as that of the Association. Notwithstanding the length of time during which the evaporative condenser has been known to some engineers, it is a common thing to hear persons say, when you ask them if they are using a condensing engine, "I cannot use it; I have not water enough." A very sufficient answer indeed, if an injection condenser, or an ordinary surface condenser, constituted the sole means by which a vacuous condition might be obtained; but a very insufficient answer, having regard to the existence of the evaporative condenser, as by its means, whenever there is water enough for the feed of a non-condensing engine, there is enough to condense, and to produce a good vacuum. The evaporative condenser simply consists of a series of pipes, in which is the steam to be condensed, and over which the water is allowed to fall in a continuous rain. By this arrangement there is evaporated from the outside of the condenser a weight of water which goes away in a cloud of vapour, and is nearly equal to that which is condensed, and is returned as feed into the boiler. The same water is pumped up and used outside the condenser, over and

* Paper read in Section G, (Mechanical) of the British Association.

over, needing no more to supply the waste than would be needed as feed water. Although this condenser has, as I have said, been in use for thirty or forty years, one still sees engines working without condensation at all, or with water-works water, purchased at a great cost, and to the detriment of other consumers, who want it for ordinary domestic purposes; or one sees large condensing ponds made, in which the injection water is stored, to be used over and over again, and frequently (especially towards the end of the week) in so tepid a state as to be unfit for its purpose. The governing is now done by means of quick-running governors, which have power enough in them to raise not merely the weight of the pendulum ball, which is now small, but a very heavy weight, and in this way the governing is extremely effective. I propose to say no more, looking at the magnitude of the whole of my subject, upon the engine used for manufacturing purposes, but rather to turn at once to those employed for other objects.

Steam navigation.—In 1831, there were a considerable number of paddle steamers running along some of the rivers in England, and across the Channel to the Continent. But there were no ocean steamers, properly so-called, and there were no steamers used for warlike purposes. As in the case of the waggon boilers, the boilers of the paddle steamers of 1831 were most unsuited for resisting pressure. They were mere tanks, and there was as much pressure when there was no steam in the boiler from the weight of the water on the bottom, as there was at the top of the boiler from the steam pressure when the steam was up. Under these circumstances again, from 3½ lbs. to 5 lbs. was all the pressure the boilers were competent to bear, and as the engines ran at a slow speed, they developed but a small amount of horse-power in relation to their size. Moreover, as in the land engine, the connection between the parts of the marine engine was such as to be incompetent to stand the strain that would come upon it if a higher pressure, with a considerable expansion, were used, and thus the consumption of coal was very heavy; and we know, that having regard to the then consumption, it was said on high authority, it would be impossible for a steamboat to traverse the Atlantic, as it could not carry fuel enough to take it across; and indeed it was not until 1838 that the *Sirius* and the *Great Western* did make the passage. The passage had been made before, but it was not until 1838 that the passenger service can be said to have commenced. In 1831, the marine boiler was supplied with salt water, the hulls were invariably of wood, and the speed was probably from eight to nine knots an hour. In 1881, the vessels are as invariably either of iron or of steel, and I believe it will not be very long before the iron disappears, giving place entirely to the last-mentioned metal. With respect to the term "steel," I am ready to agree that it is impossible to say where, chemically speaking, iron ends and steel begins. But (leaving out malleable cast iron) I apply this term "steel" to any malleable ductile metal of which iron forms the principal element, and which has been in fusion, and I do so in contra-distinction to the metal which may be similar chemically, but which has been prepared by the puddling process. Applying the term steel in that sense, I believe, as I have said, it will not be very long before plate-iron produced by the puddling process will cease to be used for the purpose of building vessels. With respect to marine engines, they are now supplied with steam from multiple-tubed boilers, the shells of which are commonly cylindrical. They are of enormous strength, and made with every possible care, and carry from 80 lbs. to 100 lbs. pressure on the square inch. It has been found, on the whole, more convenient to expand the steam in two or more cylinders, rather than in one. I quite agree that, as a mere matter of engineering science, there is no reason why the expansion should not take place in a single cylinder, unless it be that a single cylinder is cooled down to an extent which cannot be overcome by jacketting, and which, therefore, destroy, a portion of the steam on its entering into the cylinder. As regards the propeller, as we know, except in certain cases, the paddle-wheel has practically disappeared, and the screw propeller is all but universally employed. The substitution of the screw propeller for the paddle enables the engine to work at a much higher number of revolutions per minute, and thus a very great piston speed, some 600 ft. to 800 ft. per minute is attained; and this, coupled with the fairly high mean pressure which prevails, enables a large power to be got from a comparatively small-sized engine. Speeds of 15 knots an hour are now in many cases maintained, and on trial trips are not uncommonly exceeded. Steam vessels are now the accepted vessel of war. We have them in an armoured state, and in an unarmoured state, but when unarmoured rendered so formidable, by the command which their speed gives them of chosing their distance, as to make them, when furnished with powerful guns, dangerous opponents even to the best armoured vessels. We have also now marine engines, governed by governors of such extreme sensitiveness, as to give them the semblance of being endowed with the spirit of prophecy, as they appear rather to be regulating the engine for that which is about to take place than for that which is taking place. This may sound a somewhat extravagant statement, but it is so nearly the truth, that I have hardly gone outside of it in using the words I have employed. For a marine governor to be of any use, it must not wait till the stern of the vessel is out of the water before it acts to check the engine and reduce the speed. Nothing but the most sensitive and, indeed, anticipatory action of the governors can efficiently control marine propulsion. Instances are on record of vessels having engines without marine governors being detained by stress of weather at the mouth of the Thames, while vessels having such governors, of good design, have gone to Newcastle, have come back, and have found the other vessels still waiting for more favourable weather. With respect to condensation in marine engines, it is almost invariably effected by surface condensers, and thus it is that the boilers, instead of being fed with salt water as they used to be, involving continuous blowing off, and frequently the salting up, of the boiler, are now fed with distilled water. It should be noticed, however, that in some instances, owing to the absence of a thin protecting scale upon the tubes and plates, very considerable corrosion has taken place when distilled water, derived from condensers having un-

tinued brass tubes, has been used, and where the water has carried into the boiler fatty acids, arising from the decomposition of the grease used in the engine; but means are now employed by which these effects are counteracted.

I wish, before quitting this section of my subject, to call your attention to two very interesting, but very different, kinds of marine engines. One is the high-speed torpedo vessel, or steam launch, of which Messrs. Thornycroft's firm have furnished so many examples. In these, owing to the rate at which the piston runs to the initial pressure of 120 lbs., and to very great skill in the design, Messrs. Thornycroft have succeeded in obtaining a gross indicated horse-power for as small a weight as half a cwt., including the boiler, the water in the boiler, the engine, the propeller shaft, and the propeller itself.

To obtain the needed steam from the small and light boiler, recourse has to be made to the aid of a fan blast driven into the stoke-hole. From the use of a blast in this way advantages accrue. One is, as already stated, that from a small boiler a large amount of steam is produced. Another is that the stoke-hole is kept cool; and the third is that artificial blasts thus applied are unaccompanied by the dangers which arise, when under ordinary circumstances the blast is supplied only to the ash-pit itself. The second marine engine to which I wish to call your attention, is one that has been made with a view to great economy. The principles followed in its construction are among those suggested by the President (Sir W. G. Armstrong) in his address. He (you will remember) pointed out that the direction in which economy in the steam-engine was to be looked for was that of increasing the initial pressure; although at the same time he said that there were drawbacks in the shape of greater loss, by radiation, and by the higher temperature at which the products of combustion would escape. We must admit the fact of the latter source of loss, when using very high steam, it being inevitable that the temperature of the products of combustion escaping from a boiler under these conditions must be higher than those which need be allowed to escape when lower steam is employed; although I regret to say that in practice in marine boilers working at comparatively low pressures the products are ordinarily suffered to pass into the funnel at above the temperature of melted lead. But with respect to the loss by radiation in the particular engine I am about to mention—that of Perkins—there is not as much loss as that which prevails in the ordinary marine boilers, because the Perkins boiler is completely enclosed, with the result that while there is within the case a boiler containing steam of 400 lbs. on the square inch, and the fire to generate that steam, the hand may be applied to the casing itself, which contains the whole of the boiler, without receiving any unpleasant sensation of warmth. By Mr. Perkins's arrangement, using steam of 400 lbs. in the boiler, it was found, as the result of very severe trials, conducted by Mr. Rich, of Messrs. Easton and Anderson's firm, and myself—trials which lasted for twelve hours—that the total consumption of fuel, including that for getting up steam from cold water, was just under 1·8, actually 1·79 lb. per gross indicated horse-power per hour. That gross indicated horse-power was obtained in a manner which it is desirable should always be employed in steamboat trials. It was not got by using as a divisor the horse-power of the most favourable diagram obtained during the day; but it was got from diagrams taken during the regular work; then, every half-hour, when the pressure began to die down from coal being no longer put upon the fire, diagrams taken every quarter-of-an-hour, and then, towards the last, every five minutes; and the total number of foot pounds were calculated from these diagrams, and were used to obtain the gross indicated horse-power.

Further, so far as could be ascertained by the process of commencing a trial with a known fire, and closing that trial at the end of six hours, with the fire as nearly as possible in the same condition, the consumption was 1·66 lbs. of coal per gross indicated horse-power per hour. So that, without taking into account the coal consumed in raising steam from cold water, the engine worked for $1\frac{2}{3}$ lbs. of coal per horse per hour. I think it well to give these details, because undoubtedly it is an extremely economical result. Our President alluded to the employment of ether as a means of utilising the heat which escaped into the condenser, and gave some account of what was done by Mons. Du Tremblay in this direction. It so happened that I had occasion to investigate the matter at the time of Du Tremblay's experiments; very little was effected here in England, one difficulty being the Excise interference with the manufacture of ether. Chloroform was used here, and it was also suggested to employ bi-sulphide of carbon. In France, however, a great deal was done. Four large vessels were fitted with the ether engines, and I went over to Marseilles to see them at work. I took diagrams from these engines, and there is no doubt that, by this system, the exhaust steam from the steam cylinder, which was condensed by the application of ether to the surface of the steam condenser (producing a respectable vacuum of about 22 inches), gave an ether pressure of 15 lbs. on the square inch above atmosphere, and very economical results as regards fuel were obtained. The scheme was, however, abandoned from practical difficulties. It need hardly be said that ether vapour is very difficult to deal with, and although ether is light, the vapour is extremely heavy, and if there is any leakage, it goes down into the bilges by gravitation, and being mixed with air, unless due care is taken to prevent access to the fires, there would be a constant risk of a violent explosion. In fact, it was necessary to treat the engine-room in the way in which a fiery colliery would be treated. The lighting, for instance, was by lamps external to the engine-room, and shining through thick plate-glass. The hand lamps were Davy's. The ether engine was a bold experiment in applied science, and one that entitles Du Tremblay's name to be preserved, and to be mentioned as it was by our President. There was another kind of marine engine, that I think should not be passed over without notice; I allude to Howard's quicksilver engine. The experiments with this engine were persevered in for some considerable time, and it was actually used for practical purposes in pro-

pelling a passenger steam-vessel called the *Vesta*, and running between London to Ramsgate. In that engine the boiler had a double-bottom, containing an amalgam of quicksilver and lead. This amalgam served as a reservoir of heat, which it took up from the fire below the double-bottom, and gave forth at intervals to the water above it. There was no water in the boiler, in the ordinary sense of the term, but when steam was wanted to start the engine, a small quantity of water was injected by means of a hand-pump, and after the engine was started, there was pumped by it into the boiler, at each half revolution, as much water as would make the steam needed. This water was flashed on the top surface of the reservoir in which the amalgam was confined, and was entirely turned into steam, the object of the engineers in charge being to send in so much water as would just generate the steam, but so as not to leave any water in the boiler. The engines of the *Vesta* were made by Mr. Penn, for Mr. Howard, of the King and Queen Ironworks, Rotherhithe. Mr. Howard, was, I fear, a considerable loser by his meritorious efforts to improve the steam-engine.

There was used, with this engine, an almost unknown mode of obtaining fresh water for the boiler. Fresh water, it will be seen, was a necessity in this mode of evaporation. The presence of salt, or of any other impurity, when the whole of the water was flashed into steam, must have caused a deposit on the top of the amalgam chamber at each operation. Fresh water, therefore, was needed; the problem arose how to get it; and that problem was solved, not by the use of surface condensation, but by the employment of re-injection, that is to say, the water delivered from the hot-well was passed into pipes external to the vessel; after traversing them, it came back into the injection tank sufficiently cooled to be used again. The boilers were worked by coke fires, urged by a fan blast in their ashpits, but I am not aware that this mode of firing was a needful part of the system.

I come now to the *Engines used for railways*. At the British Association meeting of 1831, the Manchester and Liverpool Railway had been opened only about a year. The Stockton and Darlington coal line, it is true, had carried passengers by steam-power as early as 1825, but I think we may look upon the Manchester and Liverpool as being the beginning of the passenger and mercantile railway system of the present day. At that time the locomotives weighed from eight to ten tons, and the speed was about 20 miles per hour, with a pressure of from 40 to 50 lbs. The rails were light; they were jointed in the chairs, which were generally carried on stone blocks, thus affording most excellent anvils for the battering to pieces of the ends of the rails—that is to say, for the destruction of the very parts where they were most vulnerable. The engines were not competent to draw heavy trains, and it was a common practice to have at the foot of an incline a shed containing a "bank-engine," which ran out after the trains as they passed, and pushed them up to the top of the hill. Injectors were then unknown, and donkey-pumps were unknown, and therefore, when it was necessary to fill up the boiler, if it had not been properly pumped up before the locomotive came to rest, it had to run about the line in order to work its feed-pumps. To get over this difficulty, it was occasionally the practice to insert into a line of rails, in a siding, a pair of wheels, with their tops level with that of the rails so that the engine wheels could run upon the rims. Then, the locomotive being fixed to prevent it from moving of the pair of wheels thus endways, it was put into revolution, its driving wheels bearing, as already stated, upon the rims of the pair of wheels in the rails, and thus the engine worked its feed pumps without interfering (by its needless running up and down the line) with the traffic. It should have been stated that at this time there was no link motion, no practical expansion of the steam, and that even the reversal of the engine had to be effected by working the slides by hand gear, in the manner in use in marine engines. When the British Association originated, although the Manchester and Liverpool Railway had been opened for a year, there is no doubt that the 300 members who then came to this City found their way here by the slow process of the stage-coach, the loss of which we so much deplore in the summer and in fine weather, but the obligatory use of which we should so much regret in the miserable weather now prevailing in these islands.

In 1881, we know that railways are everywhere inserted. Steel rails, double the weight of the original iron ones, are used. Wooden sleepers have replaced the stone blocks, and they, in their turn, will probably give way to sleepers of steel. The joints are now made by means of fish-plates, and the most vulnerable part of the rail, the end, is no longer laid on an anvil for a purpose of being smashed to pieces, but the ends of the rails are now almost always over a void, and thereby are not more affected by wear than is any other part of the rail. The speed is now from 50 to 60 miles an hour for passenger trains, while slow speed goods engines, weighing 45 tons, draw behind them coal trains of 800 tons. The injector is now commonly employed, and, by its aid, a careful driver of the engine of a stopping train can fill up his boiler while at rest at the stations. The link motion is in common use, to which, no doubt, is owing the very considerable economy with which the locomotive engine now works.

As regards the question of safety, it is a fact that, notwithstanding the increased speed, railway accidents are fewer than they were at the slow speed. It is also a fact that, if the whole population of London were to take a railway journey, there would be but one death arising out of it. Four millions of journeys for one death of a passenger from causes beyond his own control is, I believe, a state of security which rarely prevails elsewhere. As an instance, the street accidents in London alone cause between 200 and 300 deaths per annum. This safety in railway travelling is no doubt largely due to the block system, rendered possible by the electric telegraph; and also to the efficient interlocking of points and signals, which render it impossible now for a signalman to give an unsafe signal. He may give a wrong one, in the sense of inviting the wrong train to come in; but, although wrong in this sense, it would still be safe for that train to do so. If he can give a signal, that signal never invites to danger; before he can give it, every one of the signals, which ought

to be "at danger," must be "at danger," and every "point" must have been previously set, so as to make the road right; then, again, we have the facing point-lock, which is a great source of safety.

Further, we have continuous brakes of various kinds, competent in practice to absorb three miles of speed in every second of time; that is to say, if a train were going 60 miles an hour, it can be pulled up in 20 seconds; or, if at the rate of 30 miles, in 10 seconds. With a train running at 50 miles an hour, it can be pulled up in from 15 to 20 seconds, and in a distance of from 180 to 240 yards. Moreover, in the event of the train separating into two or more sections, the brakes are automatically applied to each section, thereby bringing them to rest in a short time. Another cause of safety is undoubtedly the use of weldless tyres. I was fortunate enough to attend the British Association Meeting many years ago at Birmingham, and I then read a paper upon weldless tyres, in which I ventured to prophesy that, in ten years time, there would not be a welded tyre made; that is one of the few prophecies that, being made before the event, have been fulfilled. I may perhaps be permitted to mention, that at the same time I laid before the Section plans and suggestions for the making of the cylindrical parts of boilers equally without seam, or even welding. This is rarely done at the present time, but I am sure that, in twenty years time, such a thing as a longitudinal seam of rivets in a boiler will be unknown. There is no reason why the successive rings of boiler shells should not be made weldless, as tyres are now made weldless.

The next subject I intend to deal with is that of *Motors*. In 1831, we had the steam-engine, the water-wheel, the windmill, horse-power, manual power, and Stirling's hot-air engines. Gas engines, indeed, were proposed in 1824, but were not brought to the really practical stage. We had then tide mills; indeed, we have had them until quite lately, and it may be that some still exist; they were sources of economy in our fuel, and their abandonment, is to me a matter of regret. I remember tide mills on the coast between Brighton and Newhaven, another between Greenwich and Woolwich, another at Northfleet, and in many other places. Indeed, such mills were used pretty extensively; they were generally erected at the mouth of a stream, and in that way the river bed made the reservoir, and even when they were erected in other situations, those were of a kind suitable for the purpose, that is, low lying lands were selected, and were embanked to form reservoirs. In 1881, windmills and water-wheels are much the same, but the turbines are greatly improved, and by means of turbines we are enabled to make available the pressure derived from heads of water which formerly could not be used at all, or if used, involved the erection of enormous water-wheels, such as those at Glasgow and in the Isle of Man, wheels of some eighty feet in diameter. But now, by means of a small turbine, an excellent effect is produced from high heads of water. The same effect is obtained from the water-engines which our President has employed with such great success. In addition o these motors, we have the gas-engine, which, within the last few years only, has become a really useful working and economical machine. With respect to horse-power motors, we have not only the old horse engines,) but we have a new application (as it seems to me, of the work of the horse as a motor. I allude to those cases where the horse drawing a reaping or threshing machine, not only pulls it forward as he might pull a cart, but causes its machinery to revolve, so as to perform the desired kind of work. This species of horse-engine, though known, was but little used in 1831. With respect to hot-air engines there have been many attempts to improve them, and some hot-air engines are working, and are working with considerable success; but the amount of power they develop in relation to their size is small, and I am inclined to doubt whether it can be much increased.

I now come to the subject of the *transmission of power*. I do not mean transmission in the ordinary sense by means of shafting, gearing, or belting, but I mean transmission over long distances. In 1831, we had for this purpose flat rods, as they were called, rods transmitting power from pumping engines for a considerable distance to the pits where the pumps were placed, and we had also the pneumatic, the exhaustion system—the invention of John Hague, a Yorkshireman, my old master, to whom I was apprenticed—which mode of transmission was then used to a very considerable extent. The recollection of it, I find, however, has nearly died out, and I am glad to have this opportunity of reviving it. But in 1881, we have, for the transmission of power, first of all, quick moving ropes, and there is not, so far as I know, a better instance of this system than that at Schaffhausen. Anyone who has ever, in recent years, gone a mile or two above the falls at Schaffhausen must have seen there—in a house, on the bank of the Rhine, opposite to that on which the town is situated—large turbines driven by the river, which is slightly dammed up for the purpose These work quick-going ropes, carried on pulleys, erected at intervals along the river bank, for the whole length of the town; and power is delivered from them to shafting below the streets, and from it into any house where it is required for manufacturing purposes. Then we have the compressed air transmission of power, which is very largely used for underground engines, and for the working of rock drills in mines and tunnels. We have also compressed air in a portable form, and it is now employed with great success in driving tram-cars. I had occasion last January to visit Nantes, where, for eighteen months, tram-cars had been driven by compressed air, carried on the cars themselves, coupled with an extremely ingenious arrangement for overcoming the difficulties commonly attendant on the use of compressed air engines. This consists in the provision of a cylindrical vessel half filled with hot water and half with steam, at a pressure of eighty pounds on the square inch. The compressed air, on its way from the reservoir to the engine, passes through the water and steam, becoming thereby heated and moistened, and in that way all the danger of forming ice in the cylinders was prevented, and the parts were susceptible of good lubrication. These cars, which start every ten minutes from each end, make a journey of $3\frac{3}{4}$ miles, and have proved to be a commercial and an engineering success. I believe, moreover,

that they are capable of very considerable improvement. Then there is, although not much used, the transmitting of power by means of long steam pipes. There is also the transmission hydraulically. This may be carried out in an intermittent manner, so as to replace the reciprocating flat rods of old days; that is to say, if two pipes containing water are laid down, and if the pressure in those pipes at the one end be alternated, there will be produced an alternating and a reciprocative effect at the other, to give motion to pumps or other machinery. There is also that thoroughly well known mode of transmission, hydraulically, for which the engineering world owes so much to our President. We have, by Sir William Armstrong's system, coupled with his accumulator, the means of transmitting hydraulically the power of a central motor to any place requiring it, and by the means of the principal accumulator, or if need be, by that aided by local accumulators, a comparatively small engine is enabled to meet very heavy demands made upon it for a short time. I think I am right in saying that, at the ordinary pressure which Sir William Armstrong uses in practice, viz., 700 lbs. to the square inch, one foot a second of motion along an inch pipe would deliver at the rate to produce one-horse power. Therefore, a ten-inch pipe, with the water travelling at no greater pace than three feet in a second, would deliver 300-horse power. This 300-horse power would no doubt be somewhat reduced by the loss in the hydraulic engine, which would utilise the water. But the total energy received would be equivalent to producing 300-horse power. Such a transmission would be effected with an exceedingly small loss in friction in transit. I believe I am right in saying that a 10-inch pipe a mile long would not involve much more than about 14 or 15 lbs. differential pressure to propel the water through it at a rate of three feet in a second. If that be so, then, with 700 lbs. to the inch, the loss under such circumstances would be only two per cent. in transmission. There is no doubt that this transmission of power hydraulically has been of the greatest possible use. It has enabled work to be done which could not be done before. Enormous weights are raised with facility wherever required, as by the aid of power hydraulically transmitted, it is perfectly easy for one man to manage the heaviest cranes. Moreover, as I have said in other places, the system which we owe to Sir William Armstrong has gone far to elevate the human race, and it has done so in this manner. So long as it is competent for a man to earn a living by mere unintelligent exercise of his muscles, he is very likely to do it. You may see in the old London docks the crane-heads covered by structures that look like paddle-boxes. If you go to them, there is, I am glad to say, nothing now to fill them up; but when the British Association first met, these paddle-boxes covered large treadwheels, in which the men trod, so as to raise a weight. Now, although I know that in fact there is nothing more objectionable in a man turning a wheel by treading inside of it than there is if he turn it round by a winch-handle, yet somehow it strikes one more as being merely the work of an animal, a turnspit, or a squirrel, or indeed as the task imposed on the criminal. But, nevertheless, in this way there were a large number of persons getting their living by the mere exercise of their muscles, but, as might be expected, a very poor living, derived as it was from unintelligent labour. That work is no longer possible, and is not so, for the powerful reason that it does not pay. Those persons, therefore, who would now have been thus occupied, are compelled to elevate themselves, and to become competent to earn their living in a manner which is more worthy of an intelligent human being. It is on these grounds that I say we owe very much the elevation of the working classes, especially of the class below the artisan, to this invention of our distinguished President. In addition to the modes of transmission I have already mentioned, there is the transmission of power by means of gas. I think that there is a very large future indeed for gas engines. I do not know whether this may be the place to state it, but I believe the way in which we shall utilise our fuel hereafter will, in all probability, not be by the way of the steam-engine. Sir William Armstrong alluded to this probability in his address, and I entirely agree, if he will allow me to say so, that such a change in the production of power from fuel appears to be impending, if not in the immediate future, at all events in a time not very far remote; and however much the Mechanical Section of the British Association may to-day contemplate with regret, even the mere distant prospect of the steam-engine being a thing of the past, I very much doubt whether those who meet here fifty years hence will then speak of it as anything more than a curiosity to be found in a museum. With respect to the transmission of power electrically, I won't venture to touch upon that; but will content myself by reminding you that while Sir William Armstrong did say that there were comparatively small streams which could be utilised, he did not inform you of that which he himself had done in this direction; let me say that Sir William Armstrong thus utilised a fall of water, situated about a mile from his house, to work a turbine, which drives a dynamo machine, generating electricity, for the illumination of the house. When I was last at Crag Side, that illumination was being effected by the arc light, but since then, as Sir William Armstrong has been good enough to write to me, he has replaced the arc light by the incandescent lamp (a form of electrical lighting far more applicable than the arc light to domestic purposes), and with the greatest possible success. Thus, in Sir William Armstrong's own case, a small stream is made to afford light in a dwelling a mile away. Certainly nothing could have seemed more improbable fifty years ago than that the light of a house should be derived from a fall of water without the employment of any kind or description of fuel.

The next subject upon which I propose to touch, is that of the *Manufacture of iron and the steel.* In 1831, Neilson's hot blast specification had been published for $2\frac{1}{2}$ years only. The Butterly Company had tried the hot blast for the first time in the November preceding the meeting of the British Association. The heating of the blast was coming very slowly into use, and the tem-

perature attained when it was employed was only some 600 degrees. The ordinary blast furnace of those days was 35 to 40 feet high, and about 12 feet diameter at the boshes, and turned out about 60 tons a week. It used about 2½ tons of coal per ton of iron, and no attempt was made to utilise the waste gases, whether escaping in the form of gas or in the form of flame, the country being illuminated for miles around at night by these fires. The furnaces were also open at the hearth, and continuous fire poured out along with the slag. In 1881, blast furnaces are from 90 ft. to 100 ft. high, and 25 ft. in diameter at the boshes; they turn out from 500 to 800 tons a-week. The tops and also the hearths are closed, and the blast—thanks to the use of Mr. E. A. Cowper's stoves—is at 1,200 degrees. The manufacture of iron has also now enlisted in its service the chemist as well as the engineer, and amongst those who have done much for the improvement of the blast furnaces, to no one is greater praise due than to Mr. Isaac Lowthian Bell, who has brought the manufacture of iron to the position of a highly scientific operation. In the production of wrought iron by the puddling process, and in the subsequent mill operations, there is no very considerable change, except in the magnitude of the machines employed, and in the greater rapidity with which they now run. In saying this, I am not forgetting the various "mechanical puddlers" which have been put to work, nor the attempts that have been made by the use of some of them to make wrought iron direct from the ore; but neither the "mechanical puddler" nor the "direct process" have yet come into general use; and I desire to be taken as speaking of that which is the ordinary process pursued at the present in puddled iron manufactures. In 1831, a few hundredweights was the limit of weight of a plate, while in 1881, there may readily be obtained, for boiler-making purposes, plates of at least four times the weight of those that were made in 1831. I may, perhaps, be allowed to say that there is an extremely interesting Blue-book of the year 1818, containing the report of a Parliamentary Committee which sat on boiler explosions, and I recommend any mechanical engineer who is interested in the history of the subject to read that book; he will find it there stated that in the North of England there were a species of engines called locomotives, the boilers of which were made of wrought iron beaten, not rolled, because the rolled plate was not considered fit; it was added that if made of beaten iron the boiler would last at least a year. In 1831, thirteen years later, the dimensions of rolled plates were no doubt raised; but few then would have supposed it possible there should be rolled such plates as are now produced for boiler purposes, and still fewer would have believed that in the year 1881 we should make, for warlike purposes, rolled plates 22 inches in thickness and 30 tons in weight. I have said there is very little alteration in the process of making wrought iron by puddling, and I do not think there is likely to be much further, if any, improvement in this process, because I believe that, with certain exceptions, the manufacture of iron by puddling is a doomed industry. I ventured to say, in a lecture I delivered at the Royal Institution three years ago on "The Future of Steel," that I believed puddled iron, except for the mere hand-wrought forge purposes of the country blacksmith, and for such like purposes, would soon become a thing of the past. Mr. Harrison, the engineer of the North-Eastern Railway, told me that, about eighteen months ago, the North-Eastern Railway applied for tenders for rails in any quantities between 2,000 and 10,000 tons, and they issued alternative specifications for iron and for steel. They received about ten tenders. Some did not care to tender for iron at all; but when they did tender alternatively, the price quoted for the iron was greater than that for the steel. I have no doubt whatever, that in a short time it will be practically impossible to procure iron made by the puddling process, of dimensions fit for many of the purposes for which a few years ago it alone was used. With respect to steel. In 1831, the process in use was that of cementation, producing blistered steel, which was either piled and welded to make shear steel, or was broken into small pieces, melted in pots, and run into an ingot weighing only some 50 lbs. or 60 lbs. At that time, steel was dealt in by the pound; nobody thought of steel in tons. In 1881, we are all aware that, by Sir Henry Bessemer's well-known discovery, carried out by him with such persistent vigour, cast-iron is, by the blowing process, converted into steel, and that, by Dr. Siemens's equally well-known process (now that, owing to his invention of the regenerative furnace, it is possible to obtain the necessary high temperature), steel is made upon the open hearth. We are, moreover, aware that, by both of these processes, steel is produced in quantities of many tons at a single operation, with the result that, as instanced in the case of the North-Eastern rails, steel is a cheaper material than the wrought iron made by the puddling process. One cannot pass away from the steel manufacture without alluding to Sir Joseph Whitworth's process of putting a pressure on the steel while in a tried state. By this means, the cavities which are frequently to be found in the ingot of a large size, are, while the steel is fluid, rendered considerably smaller, and the steel is thereby rendered much more sound. In conclusion of my observations on the subject of iron and steel manufacture, I wish to call attention to the invention of Messrs. Thomas and Gilchrist, by which ores of iron, containing impurities that unfitted them to be used in the manufacture of steel, are now freed from these impurities, and are thus brought into use for steel-making purposes.

Bridges.—In the year 1831, bridges of cast iron existed; but no attempt had been made to employ wrought iron in girder bridges, although Telford had employed it in the Menai Suspension Bridge; but in 1881, the introduction of railways, and the impovement in iron manufactures, have demanded, and have rendered possible the execution of such bridges as the tubular one, spanning the Menai Straits, in span of 400 feet, and the Saltash, over the Tamar, with spans of 435 feet; while recent great improvements in the manufacture of steel have rendered possible the contemplated construction of the Forth Bridge, where there are to be spans of 1,700 feet, or one-third of a mile in length. Mr. Barlow, one of the engineers of this bridge, has told me that there will be used upwards of 2,000 more tons of material in the Forth Bridge, to resist the wind pressure,

than would have been needed if no wind had to be taken into account, and if the question of the simple weight to be carried had alone to be considered. With respect to the foundation of bridges, that ingenious man, Lord Cochrane, patented a mode of sinking foundations, even before the first meeting of the British Association, viz., as far back, I believe, as 1825 or 1826; and the improvements which he then invented are almost universally in use in bridge construction at the present day. Cylinders sunk by the aid of compressed air, air-locks to obtain access to the cylinder, and in fact every means that I know of as having been used in the modern sinking of cylinder foundations, were described by Lord Cochrane (afterwards Earl of Dundonald) in that specification.

The next subject I propose to touch on, is that of *Machine Tools*. In 1831, the mention of lathes, drilling machines, and screwing machines, brings me very nearly to the end of the list of the machine tools used by turners and fitters, and at that time many lathes were without slide rests. The boilermaker had then his punching-press and shearing machine; the smith, leaving on one side his forges and their bellows, had nothing but hand tools, and the limit of these was a huge hammer, with two handles, requiring two men to work it. In anchor manufacture, it is true, a mechanical drop-hammer, known as a Hercules, was employed, while in iron works, the Helve and the Tilt hammer were in use. For ordinary smith's work, however, there were, as has been said, practically no machine tools at all.

This paucity or absence in some trades, as we have seen, of machine tools, involved the need of very considerable skill on the part of the workman. It required the smith to be a man not only of great muscular power, but to be possessed of an accurate eye and a correct judgment, in order to produce the forgings which were demanded of him, and to make the sound work that was needed, especially when that soundness was required in shafts, and in other pieces which, in those days, were looked upon as of magnitude; which, indeed, they were, relatively to the tools which could be brought to operate upon them. The boiler-maker in his work had to trust almost entirely to the eye for correctness of form and for regularity of punching, while all parts of engines and machines which could not be dealt with in the lathe, in the drilling, or in the screwing machine, had to be prepared by the use of the chisel and the file.

At the present day, the turning and fitting shops are furnished, not only with the slide lathe, self-acting in both directions, and screw-cutting, the drilling machine, and the screwing machine, but with planing machines competent to plane horizontally, vertically, or at an angle; shaping machines, rapidly reciprocating, and dealing with almost any form of work; nut-shaping machines, slot drilling machines, and slotting machines, while the drills have become multiple and radial; and the accuracy of the work is ensured by testing on large surface plates, and by the employment of Whitworth internal and external standard gauges.

The boiler-maker's tools now comprise the steam, compressed air, hydraulic or other mechanical rivetter, rolls for the bending of plates while cold into the needed cylindrical or conical forms, multiple drills for the drilling of rivet holes, planing machines to plane the edges of the plates, ingenious apparatus for flanging them, thereby dispensing with one row of rivets out of two, and roller expanders for expanding the tubes in locomotive and in marine boilers; while the punching press, where still used, is improved so as to make the holes for seams of rivets in a perfect line, and with absolute accuracy of pitch.

With respect to the smith's shop, all large pieces of work are now manipulated under heavy Nasmyth or other steam hammers; while smaller pieces of work are commonly prepared either in forging machines or under rapidly moving hammers, and when needed in sufficient numbers are made in dies. And applicable to all the three industries of the fitting shop, the boiler shop, and the smith's shop, and also to that other industry carried on in the foundry, are the travelling and swing cranes, commonly worked by shafting, or by quick moving ropes for the travellers, and by hydraulic power or by steam-engines for the swing cranes. It may safely be said that, without the aid of these implements, it would be impossible to handle the weights that are met with in machinery of the present day.

I now come to one class of machine which, humble and small as it is, has probably had a greater effect upon industry and upon domestic life than almost any other. I mean the *Sewing machine*. In 1831, there was no means of making a seam except by the laborious process of the hand needle. In 1846, Eldred Walker patented a machine for passing the basting thread through the gores of umbrellas, a machine that was very ingenious and very simple, but was utterly unlike the present sewing machine, with its eye-pointed needle, using sometimes two threads (the second being put in by a shuttle or by another needle), and making stitches at twenty-fold, the rapidity with which the most expert needle-woman could work. By means of the sewing machine not only are all textile fabrics operated upon, but even the thickest leather is dealt with, and as a *tour de force*, but as a matter of fact, sheet-iron plates themselves have been pierced, and have been united by a seam no boiler-maker ever contemplated, the piercing and the seam being produced by a Blake sewing machine. I believe all in this Section will agree that the use of the sewing machine has been unattended by loss to those who earn their living by the needle; in fact, it would not be too much to say that there has been a positive improvement in their wages.

The next matter I have to touch upon is *Agricultural machinery*. In 1831, we had threshing machines and double ploughs, and even multiple ploughs had been proposed, tried, and abandoned. Reaping machines had been experimented with and abandoned; sowing machines were in use, but not many of them; clod crushers and horse rakes were also in use; but as a fact ploughing was done by horse power with a single furrow at a time, mowing and reaping were done by the scythe or the sickle, sheaves were bound by hand, hay was tedded by hand-rakes, while all materials and produce were moved about in carts and in waggons drawn by horses. At the present time we have multiple ploughs, making five or six furrows at a time, these and cultivators also driven by steam, commonly from two engines on the head lands, the plough being in between, and worked by

a rope from each engine, or if by one engine, a capstan on the other head land, with a return rope working the plough backwards and forwards; or by what is known as the roundabout system, where the engine is fixed and the rope carried round about the field; or else ploughs and cultivators are worked by ropes from two capstans placed on the two head lands, and driven by means of a quick going rope, actuated by an engine, the position of which is not changed. And then we have reaping machines, driven at present by horses; but how long it will be before the energy residing in a battery, or that in a reservoir of compressed air, will supersede horse power to drive the reaping machine, I don't know, but I don't suppose it will be very long. The mowing and reaping machines not only cut the crop and distribute it in swathes, or, in the case of the reaping machine, in bundles, but now, in the instance of these latter machines, are competent to bind it into sheaves. In lieu of hand tedding, haymaking machines are employed, tossing the grass into the air, so as to thoroughly aerate it, taking advantage of every brief interval of fine weather; and seed and manure are distributed by machine with unfailing accuracy. The soil is drained by the aid of properly constructed ploughs for preparing the trenches; roots are steamed and sliced as food for cattle; and the threshing machine no longer merely beats out the grain, but it screens it, separates it, and elevates the straw, so as to mechanically build it up into a stack. I do not know a better class of machine than the agricultural portable engine. Every part of it is perfectly proportioned and made, it is usually of the locomotive type, and the economy of fuel in its use is extremely great. I cannot help thinking that the improvement in this respect which has taken place in these engines, and the improvement of agricultural machinery generally, is very largely due to the Royal Agricultural Society, one of the most enterprising bodies in England.

I now come to the very last subject I propose to speak upon, and that is *Printing machinery*, and especially as applied to the printing of newspapers. In 1831, we had the steam press sending out a few hundred copies in an hour, and doing that upon detached sheets, and thus many hours were required for an edition of some thousands. The only way of expediting the matter would have been to have recomposed the paper, involving, however, double labour to the compositors, and a double chance of error. At the present day, we have, by the Walter press, the paper printed on a continuous sheet at a rate per hour at least three times as great as that of the presses of 1831, and, by the aid of *papier maché* moulds, within five minutes from the starting of the first press, a second press can be got to work from the stereotype plates, and a third one in the next five minutes; and thus the wisdom of our senators, which has been delivered as late as three o'clock in the morning, is able to be transmitted by the newspaper train leaving Euston at 5.15 a.m.

This is the last matter with which I shall trouble the Section. I have purposely omitted telegraphy; I have purposely omitted artillery, textile fabrics, and the milling and preparation of grain. These and other matters I have omitted for several reasons. Some I have omitted because I was incompetent to speak upon them, others because of the want of time, and others because they more properly belong to Section A.

I hope, sir, although your address, dealing with the future, was undoubtedly the right address for a President to deliver, and although it is equally right that we should not content ourselves with merely looking back in a "rest and be thankful" spirit at the various progress which this paper records, it may nevertheless be thought well that there should have been brought before the Section, in however cursory a manner, some notice of mechanical development during the past fifty years.

GENERAL NOTES.

Vienna Art Exhibition.—An International Exhibition of the chief works of art produced since the Exhibition of 1873 will be opened at Vienna, by the Viennese Society of Artists, on April 1, 1882, and continue open until September 30. The Exhibition will comprise architectural plans and models, paintings, engravings, and sculpture. All objects intended for exhibition must be delivered at the Künslterhaus, Vienna, not later than March 1, 1882.

Patent Medicines.—According to a return just issued, the number of licenses to sell patent medicines taken out during the year ending the 31st of March last was 18,754, for which there was paid the sum of £4,688 10s. The revenue derived from stamps for patent medicines during the same time amounted to £139,762 18s. 10½d., which represented 17,198,442 stamps of different values.

"The Glow" Stove. — An open slow combustion grate on a new principle has recently been patented by Messrs. Everitt and Barnard, and will be exhibited at the Kyrle Society's Smoke Abatement Exhibition, to be held at the South Kensington Museum this month. The bottom, as in all slow combustion stoves, is closed in; below this in the front are a number of holes, carrying a draft of air beneath and parallel with the surface upon which the coal rests. These openings are connected with an air chamber at the back of the grate, which chamber has an outlet immediately over the fuel. A "Baffle" of fire brick, reaching the front and about an inch above the openings from the air chamber, extends the full width of the stove, springing from the back at an angle of about 60°. The objects of this "Baffle," which becomes red-hot, are to form a combustion chamber in which smoke is consumed, to accumulate the heat which would otherwise escape up the chimney, and to throw the accumulated heat into the room.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 7...Farmers' Club, Inns of Court Hotel, Holborn, W.C., 4 p.m. Mr. G. M. Allender, "Dairying."
British Architects, 9, Conduit-street, W., 8 p.m.

Tuesday, Nov. 8...Central Chamber of Commerce (at the House of the Society of Arts), 11 a.m.
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8.30 p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Charles Wood, "Iron Permanent Way."
Anthropological Institute, 4, St. Martin's-place, W.C., 8 p.m. 1. Mr. E. F. im Thurn, "The Animism of the Indians of British Guiana." 2. Mr. M. J. Walhouse, "Some Vestiges of Girl Sacrifices, Jar Burial, and Contracted Interments in India and the East."

Wednesday, Nov. 9...Microscopical, King's College, W.C., 8 p.m. Mr. B. Wills Richardson, "Multiple Staining of Animal and Vegetable Tissues."

Thursday, Nov. 10...Mathematical, 22, Albemarle-street, W., 8 p.m. 1. Annual Meeting. 2. Messrs. M. Jenkins and C. W. Merrifield, "Note on the Limit to the Number of Proper Fractions, &c." 3. Prof. H. Lamb, "The Oscillations of a Viscous Spheroid."

Saturday, Nov. 12...Physical, Science Schools, South Kensington S.W., 3 p.m. 1. Mr. Lewis Wright, "Spirits in Crystals." 2. Mr. C. V. Boys, "Integrating and other Apparatus for the Measurement of Electrical and Mechanical Forces."

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FRIDAY, NOVEMBER 11, 1881.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

NOTICES.

PATENT LAW DISCUSSION.

The Discussion on the Society of Arts' Patent Bill will not be held on Wednesday, November 30, as previously announced, but on Friday, December 2nd.

The discussion will be opened by Sir Frederick Bramwell, F.R.S., Chairman of the Council, and will be continued on such evenings as may be found convenient.

The Secretary will be glad to furnish tickets for the meeting to persons interested in the subject of Patent Law who are not members of the Society.

ELECTRIC LIGHTING IN THEATRES.

Mr. R. D'Oyly Carte, the proprietor of the Savoy Theatre, in the Strand, has kindly made arrangements for Members of the Society, who may wish to do so, to inspect the lighting arrangements of the Savoy Theatre, on the afternoon of to-morrow (Saturday, the 12th of November), at ten minutes before five. Members will be admitted on presentation of their visiting cards. Each member may be accompanied by one friend.

EXHIBITION OF PHOTOGRAPHIC APPLIANCES.

In connexion with the course of Cantor Lectures, which will be delivered by Captain Abney, F.R.S., on "Recent Advances in Photography," in January and February next, it is proposed to hold, in the House of the Society of Arts, an Exhibition of Photographic Appliances.

The dates of Captain Abney's Lectures are January 30, February 6, 13, and 20. The Exhibition will be kept open from January 30 till about the end of February.

The Exhibition will be of a technical character, and it is not, therefore, desired to collect photographs of artistic merit only.

The following are among the principal classes of objects sought for exhibition:—

Apparatus: cameras, lenses, tents, instantaneous shutters, slides, sensitometers, lamps (intended specially for photographic purposes), enlarging apparatus, printing and mounting apparatus, &c.

Photographic materials.

Illustrations of new processes; negatives and prints produced by new or special processes.

Appliances used in reproductive processes; specimens of illustrations produced by such processes; specimens of historical interest, as illustrations of old processes.

Lighting: models illustrative of characteristic features in the construction of glass houses; methods of fixing glass without putty or similar material; arrangements for the production of artificial light for photographic purposes.

Any person wishing to exhibit any of the above is requested to communicate with the Secretary of the Society, who will supply printed forms of application for space, and will be glad to give any further information required.

It is hoped that arrangements may be made for showing the actual working of some of the more recent processes.

LABEL FOR PLANTS.

The Council, on the recommendation of the judges in the late competition of plant labels, are prepared to renew the offer of a Society's Silver Medal, together with a prize of £5, which has been placed at their disposal for the purpose by Mr. G. F. Wilson, F.R.S., for the best label for plants.

The object of the offer is to obtain a label which may be cheap and durable, and may show legibly whatever is written or printed thereon; the label must be suitable for plants in open border. These considerations will principally govern the award.

The award will be made on the recommendation of the Committee appointed for the purpose by the Council.

Specimen labels, bearing a number or motto, and accompanied by a sealed envelope containing the name of the sender, must be sent in to the Secretary of the Society, not later than the 1st May, 1882.

The Council reserve to themselves the right of withholding medal and prize offered, if, in the opinion of the judges, none of the specimens sent in are deserving.

ARRANGEMENTS FOR THE SESSION.

The first meeting of the One Hundred and Twenty-eighth Session of the Society will be held on Wednesday, the 16th inst., when the Opening Address will be delivered by Sir Frederick J. Bramwell, F.R.S., Chairman of the Council, and the Medals awarded during the last Session will be presented. Previous to Christmas, there will be four ordinary meetings in addition to the opening meeting.

Candidates proposed for election as members are privileged to attend the opening meeting.

Ordinary Meetings.

The following arrangements for the Wednesday evenings before Christmas have been made:—

November 16.—Opening Meeting of the Session. Address by Sir Frederick J. Bramwell, F.R.S., Chairman of the Council.

November 23.—"The Storage of Electricity." By Prof. Sylvanus Thompson, D.Sc.

November 30.—"The Distribution of Time by a System of Pneumatic Clocks." By J. A. Berly.

December 7.—"The American System of Heating Towns by Steam." By Capt. Douglas Galton, C.B., F.R.S.

December 14.—"Electric Lighting at the Paris Electrical Exhibition." By W. H. Preece, F.R.S.

At the meetings after Christmas, the following papers (among others) will be read:—

"Practical Hints on the Manufacture of Gelatine Emulsions and Plates for Photographic Purposes." By W. K. Burton.

"Stained Glass Windows." By Lewis Foreman Day.

"Photometric Standards." By Harold Dixon.

"Telephonic Communication." By Lieut.-Col. C. E. Webber.

"The Causes and Remedies of Bad Trade." By Walter R. Browne, M.A.

"The Native Tribes of the Hudson's Bay Territories." By Dr. Rae, F.R.S.

"The Manufacture of Ordnance." By Colonel Maitland.

"Some Practical Aspects of Recent Investigations in Nitrification." By R. Warington.

"The Production and Use of Gas for Purposes of Heating and Motive Power." By J. Emerson Dowson.

"Gas for Lighthouses." (Illustrated by an exhibition of some of the gas flames and apparatus used in lighthouses.) By John Wigham.

"The Relation of Botanical Science to Ornamental Art." By F. Edward Hulme, F.L.S., F.S.A.

"The High-pressure Steam-engine." By Loftus Perkins.

"The Industrial Resources of Ireland." By G. Phillips Bevan.

"A New Antiseptic Compound, and its Application to the Preservation of Food." By Prof. Barff, M.A.

"Tonnage Measurement." By Admiral Sir R. Spencer Robinson, K.C.B., F.R.S.

"Tools and Cutting Edges." By D. A. Aird.

"The Teaching of Forestry." By Colonel G. F. Pearson.

"The Art of Turning." By P. W. Hasluck.

Foreign and Colonial Section.

The meetings of this Section will take place on the following Tuesday Evenings, at Eight o'clock:—

January 31; February 28; March 21; April 4, 25; May 23.

Applied Chemistry and Physics Section.

The meetings of this Section will take place on the following Thursday Evenings, at Eight o'clock:—

January 26; February 23; March 9, 30; April 27; May 11.

Indian Section.

The meetings of this Section will take place on the following Friday Evenings, at Eight o'clock:—

February 17; March 17, 31; April 21; May 12, 26.

Cantor Lectures.

The First Course will be on "Some of the Industrial Uses of the Calcium Compounds." By Thomas Bolas, F.C.S.

November 21, 28; December 5, 12.

The Second Course will be on "Recent Advances in Photography." By Capt. Abney, R.E., F.R.S.

January 30; February 6, 13, 20.

The Third Course will be on "Hydraulic Machinery." By Prof. John Perry.

March 6, 13, 20, 27.

The Fourth Course will be on "Book Illustration, Old and New." By J. Comyns Carr.

April 20; May 1, 8, 15.

Syllabus of the First Course.

Lecture I.

Distribution and occurrence of calcium in nature. Carbonate of lime as limestone, chalk, marble, calcspar, shells, &c. Notes on some of the calcium minerals. Short survey of the chemistry of calcium and of its derivations.

Lecture II.

Lime. The calcination of the carbonate in theory and practice. Influence of foreign bodies on the quality of the lime. Most favourable conditions for the decomposition of pure and impure forms of calcium carbonate. Cements and their uses. Lime as a refractory material. Lime-light. The oxyhydrogen furnace. Lime moulds for the casting of iron and steel. Notes on a few of the industrial and economic uses of lime.

LECTURE III.

Sulphate of lime and its occurrence in nature. Gypsum and alabaster. Plaster of Paris, its preparation and uses. Physical and chemical aspects of the setting of plaster. Accelerating and retarding influences. Scientific principles involved in some of the applications of plaster. Moulding, stereotyping, and other processes.

LECTURE IV.

Other calcium compounds and their uses. The phosphorescent sulphide. Lime soaps. Bleaching powder. Phosphates of calcium. Organic calcine salts. The hardness of water, &c.

JUVENILE LECTURES.

The two Juvenile Lectures will be by W. H. PREECE, F.R.S., on "Recent Wonders of Electricity." The dates for these are Wednesday evenings, December 28 and January 4. The Lectures will commence at 7 o'clock.

Special tickets will be issued for these lectures, due announcement of which will be made.

ADMISSION TO MEETINGS.

Members have the right of attending all the Society's meetings and lectures. They require no tickets (except for the Juvenile Lectures), but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose have been issued to the Members, but admission can also be obtained on the personal introduction of a Member.

ANNUAL GENERAL MEETING.

The Anuual General Meeting will be held on Wednesday, June 28, at four o'clock.

The following is a table of dates of the Evening Meetings of the Society, subject to such alteration as may be found necessary :—

	CANTOR LECTURES.	FOREIGN AND COLONIAL MEETINGS.	ORDINARY MEETINGS.	APPLIED CHEMISTRY AND PHYSICS MEETINGS.	INDIAN MEETINGS.
	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.
1881.					
NOVEMBER	— — 21 28 —	— — — —	— — 16 23 30	— — — —	— — — —
DECEMBER	5 12 — — —	— — — —	— 7 14 — —	— — — —	— — — —
1882.					
JANUARY	— — — — 30	— — — 31	— 11 18 25 —	— 26 — —	— — — —
FEBRUARY	6 13 20 — —	— — 28 —	1 8 15 22 —	— 23 — —	— — 17 —
MARCH	6 13 20 27 —	— — — 21	1 8 15 22 29	9 — — 23	— 17 — 31
APRIL	— — — 24 —	— 4 — 25	— 19 26 — —	— 27 — —	— 21 — —
MAY	1 8 15 — —	— — 23 —	3 10 17 24 31	4 — — —	12 — — 26

THE CHAIR WILL BE TAKEN AT EIGHT O'CLOCK AT EACH OF THE ABOVE MEETINGS.

MISCELLANEOUS.

THE CULTIVATION OF THE RAMEH PLANT.

The rameh plant possesses qualities and merits of the highest value for textile industries, and in the whole of Europe, Consul Stanton states, that France alone has attempted the industrial development of this Chinese plant, and the attempt has met with such success as to give that country a decided advantage over other European manufacturing countries. At the present time the cultivation makes great progress in Southern France, Corsica, and Algiers, and a practical process has lately been discovered for separating the fibres from the stems. The plant belongs to the nettle family, and although stingless, is similar to the stinging nettle in the form both of its leaves and branches, having, however, a much more luxuriant growth. The branches grow straight, and in bunches, and are composed of a brittle, woody substance, filled with pith, and surrounded with a fibrous covering which, in its turn, is covered with a thin skin or rind. The fibres are bound together by a resinous substance, which is more difficult to dissolve than that contained in flax and hemp, and from this circumstance the setting of the rameh plant is more laborious than hemp and flax, though the hackling of the stems is less arduous. The propagation of the plant may be effected by seeds, layers, or cuttings ; but as the reproduction from seeds is generally slow and uncertain, slips and layers are more often used. The rameh is a perennial, and not like flax and hemp, an annual, and its strength and fertility increases with its age ; it withstands both drought and damp, but is very susceptible to frost. Even after frost, however, it is only the first crop which is lost, since the roots, which penetrate the ground to a depth of about a foot, are seldom affected, and soon put forth new shoots. Its growth is unusually rapid, and even in France it attains annually a height of from six to eight feet. In its home, however (China and Bengal), it attains the height of 15 feet. By cutting the stems when they have attained a height of three feet, several crops and finer fibres are obtained, the plant renewing its shoots continually. The leaves, when dried, are valuable for the manufacture of the tough paper which is so ex-

tensively used in China, while the green ones afford excellent cattle fodder. On account of its luxuriant growth, extensive manuring is requisite; and, with the exception of this manuring, and the careful manner in which it must be done, the cultivation of the rameh is of the simplest kind, and with due care for frost, it may be planted at any season. The planting is generally in furrow, ten inches deep, and a yard apart, the plants being set out at intervals of a yard. Hoeing and digging are only necessary the first year, the plant growing afterwards with such luxuriance as to smother all weeds. In the spring, and after each cutting, hoeing is generally resorted to; and if, at the approach of winter, the earth is heaped up round the roots, to protect them from frost, the branches increase rapidly in number, the first growth yielding from three to four, the second from six to eight, the third from ten to twelve, and the fourth (this, however, is only in warm climates), from sixteen to twenty branches. The pecuniary results so far obtained, are most satisfactory. It is maintained that the rameh plant will yield a crop worth from £56 to £80 per hectare (2·47 acres); and assuming that three cuttings are annually obtained, there would be a yield of from 4,000 to 5,000 kilos. of leaves alone, which would cover all the expenses of cultivation. In addition to this, there would be from 1,500 to 2,200 kilos. of fibres, from which 1,200 to 1,500 kilos. of white linen could be spun. The tenacity of the rameh fibre is 30 per cent. greater than that of flax, and in consequence of this tenacity, it has for many years been used in China in the manufacture of many articles, in which solidity is absolutely necessary. In China from fibres of this plant the coarsest nets are woven, and fabrics which surpass in gloss and delicacy the finest battiste. As with flax and hemp, the first operation is to separate the fibres from the resinous substance which unites them; this is effected by steeping in water. The Belgians have recently substituted for the old plan, a new, more rapid, and healthier process, which produces an excellent commercial result. Large square cemented vats are used; in these the branches are laid, then water is poured on and kept, for flax and hemp, for one or two days, and for rameh from five to six days; to the water one-half per cent. of the weight of the branches, of pulverised charcoal is added, and the same quantity of carbonate of soda or potash, and throughout the process the vats are kept carefully closed. In this manner decomposition takes place slowly, and the fibres are protected from the injurious effects of the exhalations of sulphureted hydrogen. After the gluten is dissolved from the fibres, they have only to be separated from the woody tissue; this is effected by hackling, which was formerly slowly and arduously done by hand, but is now performed by machinery in a very simple manner. The branches are passed successively through four pairs of rollers, which destroy the woody tissue; then the hackling done by two pairs of grooved cylinders, which, by a movement backwards and forwards, rub and cleanse the fibres from all impurities; a third machine, which consists of a hollow cyclinder inclosing an axle, does the combing. This axle is provided with a number of whips, which beat the fibres continually; the fibres enter the cylinder at an opening in the side, the dust is removed by a ventilator, and the branches reduced to the finest fibres, leave the machine perfectly cleansed, and after bleaching are ready for spinning. In consequence of the silky character of the fibre, it is necessary to fasten the warp securely to prevent its being pulled out when weaving. Special attention is also paid to the dyeing to ensure fast colours. In France, measures have been taken for the manufacture of elegant rameh stuffs on a large scale, either from rameh for table-cloths, and furniture coverings, or mixed with wool and silk for draperies, and it is the opinion of those engaged in the manufacture of textile fabrics that the time has arrived when this material will play a great *rôle* in textile industries.

CORRESPONDENCE.

PISTACHIA GUM.

Some time ago I read in your *Journal* (vol. xxix., p. 596), that Mr. Thos. Christy, F.L.S., offered to supply any of your readers with samples of a new gum called *Pistachia terebinthus*, so that its value as an article of commerce might be tested. Having procured a sample of this gum, I will now, if you have space to spare in your valuable *Journal*, give you a few particulars as to my experiments with it, which will prove, in my opinion, its future commercial value.

This new gum, which is soluble in oil, turpentine, and alcohol, is of a light yellowish colour, and has an agreeable odour of mastic.

If the Pistachia gum is mixed with common resin, soda of a strength of 25 degrees has no soluble action on the gum, and soda of a strength even far greater than 25 degrees has, no more than water, any effect on the unadulterated Pistachia gum. These facts alone are a sufficient proof of the value of this gum for the uses to which I have subjected it in my experiments.

It is well known that most of the gums or resins now used in the manufacture of varnish are soluble in soda, and therefore yield to the action of soap in a short space of time. Now, the varnish made with Pistachia gum possesses many advantages over the ordinary varnish, for, besides being waterproof, it does not in any way yield to either the action of soap or soda, and it can also be advantageously used for oilcloth.

I found, after further experiment, that when left in contact with the open air, this new varnish thickens very quickly, which renders it a valuable acquisition to painters on glass and porcelain, both as a substitute for the burning process, or to mix with the colours now used.

The colour of this varnish can be made of different shades, varying from a light grey to a beautiful dark brown, and it has the same appearance as the ordinary varnish. Pistachia gum, while of a similar character and of the same basis as Venetian turpentine, is far more important in its composition, which ought to render it valuable for commercial and medicinal purposes, and I may add, in conclusion, that *Pistachia terebinthus* gum, as a varnish and paint, in my opinion will become in the future of great value for these purposes.

Jules Greth.

Ponder's-end.

SCIENCE TEACHING IN SCHOOLS.

The following may interest the readers of the Society of Arts' *Journal*, as affording a practical illustration of the ease with which the elementary scientific notions that have the most direct bearing on daily life, may be introduced in the schools of the people.

The views I had long entertained concerning the introduction of useful knowledge in the education of the masses, received in 1870 much encouragement from the adoption, by the London School Board, of Dr. Gladstone's plan for initiating, at an early age, by experimental as well as visual means, elementary notions about Common Things, and disseminating practical germs of thoughtful cleverness. I naturally became anxious to show how conveniently the materials for progressive lessons in physics, chemistry, and physiology, contained in my "Science made Easy" Course of ten lectures, might serve for developing in the successive standards of primary schools knowledge conducive to health, common sense, and industrial success. In order to indicate how this might be done most effectually, I invited the teachers of both sexes of the Metropolitan Board Schools to attend, in the beginning

of 1880, a special delivery of the course. By permission of the head-master, Dr. Wormell, it was given at the Middle-Class Schools in Cowper-street, where a full collection of my apparatus and diagrams was in constant use by Mr. J. Bower, one of the science masters, who added appropriate pedagogic remarks and advice. The attendance of the teachers was numerous, and their satisfaction very encouraging, as was also the manner in which a considerable number of them passed a special examination held on the so-called "open-handed" system.

My next step was to place a collection of "Science made Easy" apparatus and diagrams at the disposal of the London School Board, for being circulated seriatim, by way of experiment, to seven Board schools in various parts of the metropolis, duly supplied with copies of the ten lectures, and with "Suggestions" in a pamphlet form, for their adaptation to juvenile instruction. Each school in its turn has the use of a lecture-box for at least a fortnight, at the end of which term the multifarious contents are inspected by my special agent, cleaned, replenished and packed for being transmitted to the school next on the list. The scheme may seem an intricate one, but it is progressing admirably, thanks to the intelligent management of my secretary, who, from the Economic Museum, directs each detail of the proceedings; and to the exemplary promptness and regularity with which the Stores Department of the School Board effects the transfer of the boxes from school to school.

Though the experiment is not yet entirely completed, it has become evident that, should the London School Board be inclined to follow up the system thus initiated, a comparatively limited number of "Science made made Easy" sets would suffice to meet the requirements of the chief schools of the metropolis. They might be supplied by Messrs. Griffin, of Garrick-street, Covent-garden, who have lately completed a pattern set for the American Government, and who would contract for the periodical inspection and renovation at a charge which, according to my experience, would be moderate. A far more important point, however, is the satisfaction with which the masters appear to dispense this practical instruction, and the pleasure with which the children appear to receive it. I cannot do better than quote on this score a letter just received from the head master of one of the schools, which, being among the first on the list, has completed the use of the course:—

"The masters (including myself) liked the lessons very much, and the boys looked forward to them, so much so, that we had the highest attendance on the days the lessons were given, and it was considered a severe punishment to be sent into another room, and thus lose the science lessons. . . . . Thanking you very much for the opportunity you have placed in my way of having pleasing, useful lessons, so admirably illustrated, given in my school, I remain, yours, &c."

It is essential to make a clear distinction between a system of *connected* and progressive lessons, carefully selected with a view to practical utility, from the general range of natural science, and the plan which has hitherto prevailed, of teaching *detached* branches of science as "special subjects," with a view, perhaps, rather to the best chances of pecuniary results, than to the prospective occupations, and consequent requirements of the children. Special attainments in science and art need not be excluded in the highest standards, but they are best acquired in that secondary instruction to which so much attention is being devoted, among the more enlightened of the industrial communities of the Continent, and which amongst us is mainly represented by Evening Classes. This secondary instruction in science should diverge freely into the various channels of industrial employment. Primary science, on the contrary, whilst it should serve as a general foundation to special secondary attainments, should at the same time consist of information directly meeting the requirements of Daily Life; it should, in fact, precisely teach that knowledge which everyone ought to possess; and, accordingly, making allowance for certain natural distinctions of sex, and for a few differences depending on local circumstances, or deficient resources it should be *obligatory* and *uniform.* It should be moulded on an official programme, prepared by thoroughly competent educationalists, which would indicate, with elastic outlines, the course to be pursued, and supply alternatives for abnormal circumstances.

T. TWINING.

Twickenham.

BOILERS OF KITCHENERS.

As householders are now beginning to look forward to the winter with its consequent frosts, and as the old-fashioned kitchen ranges are being entirely superseded by the modern kitchener, it seems to me very desirable that the use of these should be properly and thoroughly understood. I find that in the ordinary dwelling houses now being built, or those of recent construction, the *double oven* kitchener is the most frequently used, and this has the boiler placed at the back of the range, and out of reach of the ordinary members of the household.

In addition to the impracticability of getting at this to clean it—a very important *dis*-advantage—there seems, in the event of a sudden and sharp frost, great danger of its bursting, if the pipes leading to and from the same to the hot-water supply should by any means become frozen.

There ought to be, and no doubt is, some simple and economical device that could be adapted to these kitcheners (without having to take out and re-set them), did but the ordinary householder know it, and it is on this ground I write, feeling sure that the insertion of this letter in the Society's *Journal* will induce some of its members to suggest a remedy, and enable every householder, so disposed, to avail himself of such suggestion, and to sleep peacefully in his bed without the fear haunting him of being suddenly blown out of it some frosty morning; and at the same time render him free from any anxiety of finding his domestics the victims of the new and, at present, imperfectly understood substitutes for the old open kitchen ranges.

F. B. W.

NOTES ON BOOKS.

Technical Vocabulary (English-French) for Scientific, Technical, and Industrial Students. By D. F. J. Wershoven. (London: Librarie Hachette et Cie. 1881.)

The words and phrases given in this book are arranged under the great headings of physics and mechanics, chemistry and metallurgy, machinery and manufactures, and an index of English words affords the reader an easy key to the classification. A list of the Latin, French, English, and German names of timber trees is added.

Reports on the Estate of Sir Andrew Chadwick, and the recent proceedings of the Chadwick Association in reference thereto, by Edmund Chadwick and James Boardman. To which is prefixed the Life and History of Sir Andrew Chadwick, by John Oldfield Chadwick. (London: Simpkin, Marshall, and Co. 1881.)

Sir Andrew Chadwick died in the year 1768, at the age of 84, leaving a considerable property, the disposal of which has given rise to a large amount of litigation.

Mr. J. O. Chadwick has described fully the various incidents connected with the carrying out of the will and its numerous codicils, and has also given an account of the early history of the Chadwicks.

GENERAL NOTES.

Manufacturers' and Mill Owners' Mutual Aid Association.—An Association has been incorporated by Act of Parliament, 1881, under this title, for the purpose of facilitating, as far as manufactories and mills are concerned, the objects proposed by the Act of 1876, for preventing the pollution of rivers, and also for the utilisation of waste products. The secretary (*pro. tem.*) is Mr. J. Breeze, and the office is at No. 5, The Sanctuary, Westminster, S.W.

Canadian Fisheries.—The supplement to the report of the Minister of Marine and Fisheries for 1880-81 contains much information relating to the value of the fisheries of Canada. The total value of the catch in the Provinces amounted to 14,500,000 dollars, in 1880 and to 13,529,250 dollars in 1879, an increase for the past year of nearly 1,000,000 dollars. The following statement shows the value of the yield of each of the principal varieties of fish:—

	Dols.		Dols.
Cod	4,534,000	Mackerel	2,178,966
Salmon	645,427	Herrings	1,511,012
Haddock	406,075	Lobsters	2,143,312
Whitefish	203,018	Trout	134,897

The codfish is obtained chiefly in Novia Scotia, where the yield reached 2,497,839 dollars, and in the Gulf of St. Lawrence, within the Province of Quebec, where it was 1,628,000 dollars. Mackerel and haddock are obtained most largely in Nova Scotia; herrings in New Brunswick; lobsters in New Brunswick, Prince Edward Island, and Nova Scotia; salmon in British Columbia; and trout and whitefish in Ontario.

South African Diamonds.—According to *The Colonies and India*, the gross weight of diamonds contained in packages passed through the Kimberley post-office, in 1880, was 1,440 lbs. 12 oz. avoirdupois, the estimated value being £3,367,897. These figures compare with 1,174 lbs. and £2,846,631 in 1879; 1,150 lbs. and £2,672,744 in 1878; 903 lbs. and £2,112,427 in 1877; and 773 lbs. and £1,807,532 in 1876. The annual value of the mines in the Kimberley division owned at the end of 1880 by the Government and the London and South African Exploration Co. is estimated as follows:—Kimberley, £4,000,000; Old De Beer's, £2,000,000; Du Toit's Pan, £2,000,000; Bullfontein, £1,500,000. At the end of last year 22,000 black and 1,700 white men were employed at these mines. From the Kimberley and Old De Beer's mines alone diamonds to the extent of 3,200,000 carats are annually raised, while the other two mines above named yielded 300,000 carrats last year. At the diggings on the Vaal River about 250 men were at work last year. The other important mining industries of the Colony are the copper mines of Namaqualand, from which last year 15,310 tons of copper were exported, valued at £306,790. From the manganese mines in the Paarl division, 206 tons were exported; while at the coal mines in the Wodehouse and Albert divisions about 1,000 tons were raised. The salt-pans in Simon's Town, Malmesbury, Piquetberg, Fraserburg, Uitenhage, and Cradock yielded about 9,000 tons of salt. Mineral springs abound in the Colony, many of them being well resorted to, but accommodation for visitors is, as a rule, indifferent.

THE LIBRARY.

The following works have been presented to the Library:—

An Outline History of the Hanseatic League, more particularly in its bearings upon English Commerce. By Cornelius Walford, F.S S. (London: Printed for private circulation, 1881.) Presented by the Author.

Plan to Liquidate the National Debt with less than the Cost of Interest. By Frederick N. Newcome. (London: Effingham Wilson.) Presented by the Author.

Ludgate-hill: Past and Present. By W. P. Treloar. (London: Griffith and Farran, 1881.) Presented by the Author.

Science for All. Vol. iv. Edited by Robert Brown, M.A., Ph.D. (London: Cassell, Petter, Galpin, and Co., 1881.) Presented by the Publishers.

Reports on the Estate of Sir Andrew Chadwick and the recent proceedings of the Chadwick Association, by Edmund Chadwick and James Boardman, to which is prefixed the Life and History of Sir Andrew Chadwick, by John Oldfield Chadwick, F.S.S. (London: Simpkin, Marshall, and Co., 1881.) Presented by the Author.

Technical Vocabulary (English-French) for Students. By Dr. F. J. Wershoven. (London: Hachette and Co., 1881.)

Birmingham Inventors and Inventions. By Richard B. Prosser. (Birmingham: "Journal" Printing Works, 1881.) Presented by the Author.

MEETINGS FOR THE ENSUING WEEK.

Monday, Nov. 14...Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Opening Address by the President, Mr. Edward Ryde.
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Opening Meeting of the Session.
Society of Chemical Industry, Burlington-house, W., 7½ p.m. 1. Address by the Chairman, Prof. Abel. 2. Dr. Messel, "The Want of Uniformity in Tables of Specific Gravity."

Tuesday, Nov. 15...Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on Mr. C. Wood's paper, "Iron Permanent Way."
Statistical, Somerset-house-terrace, Strand, W.C., 4 p.m. Opening Address, on the Land Question, by the President (Mr. J. Caird).

Wednesday, Nov. 16...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Opening Meeting of the Session. Address by Sir Frederick J. Bramwell (Chairman of the Council).
Institute of Bankers (in the Theatre cf the London Institution, Finsbury-circus, E.C.), 7 p.m. Mr. Rowland Hamilton, "Money and Barter."
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. G. J. Symons, "The Gale that passed across the British Isles, October 13th and 14th, 1881." 2. Mr. J. Wallace Peggs, "The Structural Damage caused by the Gale as indicative of Wind Force." 3. Mr. C. N. Pearson, "The Meteorology of Mozufferpore, Tirhoot, 1880."
Geological, Burlington-house, W., 8 p.m. 1. Principal J. W. Dawson, "Notes on *Prototaxites* and *Pachytheca* from the Denbighshire Grits of Corwen, North Wales." Dr. Henry Hicks, "Additional Notes on the Land Plants from the Pen-y-glog Slate-quarry, near Corwen, North Wales." 3. Mr. E. E. Berry, "Analysis of five Rocks from the Charnwood-Forest District." Communicated, with Notes, by Prof. T. G. Bonney.
Archæological Association, 32, Sackville-street, W., 8 p.m. Opening Meeting of Session. 1. Prof. Haytor Lewis, "The Boorg ez Ziffir, Cairo." 2. Mr. Gordon M. Hills, "The Measurements of Ptolemy in Relation to the Western Portion of Britain."

Thursday, Nov. 17...Royal, Burlington-house, W., 4.30 p.m.
Linnean, Burlington-house, W., 8 p.m. Sir John Lubbock, "The Sense of Colour among some of the Lower Animals." 2. Mr. C. B. Clarke, "A Hampshire Orchis not Figured in English Botany." 3. Prof. T. S. Cobbold, "New Entozoon from the Ostrich." 4. Mr. R. Irwin Lynch, "A Contrivance for Cross Fertilisation in *Roscoea purpurea.*" 5. Sir John Lubbock, "Observations on Ants, Bees, and Wasps." Part IX.
Chemical, Burlington-house, W., 8 p.m. 1. Dr. Gladstone and Mr. Tribe, "Aluminum Alcohols: their Products of Decomposition by Heat." 2. Mr. Wethered, "The Chemical Action of Decomposing Vegetable Matter on the Rich Forming Sediment of the Carboniferous Period.

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the regular receipt of the following Transactions of Societies and Periodicals during the year:—

TRANSACTIONS, &c.

Aeronautical Society, Annual Report.
Amateur Mechanical Society, Journal.
American Chemical Society, Journal.
American Society of Civil Engineers, Transactions.
Art Union of London, Report.
Bayerische Dampfkessel-Revisions-Verein, Bayerisches Industrie-und-Gewerbeblatt.
British Association for the Advancement of Science, Report.
British Association of Gas Managers, Report of the Proceedings.
British Horological Institute, Journal.
Charity Organisation Society, Reporter.
Chemical Society, Journal.
Colonial Institute, Proceedings.
East India Association, Journal.
Farmers' Club, Journal.
Franklin Institution, Journal.
Geological Society, Journal.
Geologists' Association, Proceedings.
Glasgow Philosophical Society, Poceedings.
Index Society, Publications.
India, Geological Survey of, Memoirs, Records, and Palæontologia Indica.
Indian Meteorological Memoirs.
Institute of Bankers, Journal.
Institution of Civil Engineers, Minutes of Proceedings.
Institution of Civil Engineers of Ireland, Transactions.
Institution of Engineers and Shipbuilders in Scotland, Transactions.
Institution of Mechanical Engineers, Proceedings.
Institution of Naval Architects, Transactions.
Iron and Steel Institute, Journal.
Lancashire and Cheshire, Historic Society of, Transactions.
Linnæan Society, Journal.
Liverpool Literary and Philosophical Society, Proceedings.
Manchester Field Naturalists' and Archæologists' Society, Report and Proceedings.
Manchester Literary and Philosophical Society, Memoirs.
Manchester Steam Users' Association, Monthly Report.
Meteorological Society, Quarterly Journal.
Milan. Reale Istituto Lombardo di Scienze e Lettere, Rendiconti
Musée de l'Industrie de Belgique, Bulletin.
National Association for the Promotion of Social Science, Sessional Proceedings.
National Indian Association, Journal.
National Life Boat Institution, Journal.
Pharmaceutical Society, Journal and Transactions.
Philadelphia Engineers, Club of, Proceedings.
Photographic Society, Journal.
Physical Society of London, Proceedings.
Quekett Microscopical Club, Journal.
Royal Agricultural Society, Journal.
Royal Asiatic Society, Journal.
Royal Astronomical Society, Memoirs.
Royal Colonial Institute, Proceedings.
Royal Cornwall Polytechnic Society, Report.
Royal Geographical Society, Proceedings and Journal.
Royal Irish Academy, Transactions and Proceedings.
Royal Scottish Society of Arts, Transactions.
Royal Society, Proceedings and Philosophical Transactions.
Royal United Service Institution, Journal.
Schlesische Gesellschaft für vaterländische Cultur, Jahres Bericht.
Société d'Acclimatation, Bulletin Mensuel.
Société d'Encouragement pour l'Industrie Nationale, Bulletin.
Society of Antiquaries, Archæologia and Proceedings.
Society of Biblical Archæology, Transactions.
Society of Engineers, Transactions.
Society of Telegraph Engineers, Journal.
Statistical Society, Journal.
Victoria Inst., Journal.
Württemberg, Königliche Centralstelle für Gewerbe und Handel, Jahresberichte.
Zoological Society, Proceedings and Transactions.

PERIODICALS.

Weekly.

Agricultural Gazette.
American Architect and Building News.
American Gas Light Journal.
American Pottery and Glassware Reporter.
Architect.
Athenæum.
Bombay Gazette, Overland Summary.
British Architect and Northern Engineer.
British Journal of Photography.
British Mercantile Gazette.
Builder.
Building News.
Builders' Weekly Reporter.
Capital and Labour.
Ceylon Observer, and Weekly Summary of Intelligence.
Ceylon Times, Weekly Summary.
Chamber of Agriculture Journal and Farmers' Chronicle.
Chemical News.
Chemiker-Zeitung.
Colliery Guardian.
Colonies and India.
Design and Work.
Draper.
Electrician.
Electricité, L'.
Empire.
Engineer.
Engineering.
Engineering and Building Times.
English Mechanic.
European Mail.
Farmer.
Furniture Gazette.
Gardeners' Chronicle.
Herapath's Railway Journal
India, Times of (overland weekly edition).
Inventors' Record and Industrial Guardian.
Irish Builder.
Iron.
Iron Age.
Ironmonger.
Journal d'Hygiène.
Journal of Gas Lighting.
Land and Water.
Les Mondes.
Local Government Chronicle.
London and China Telegraph.
London Iron Trade Exchange.
Metropolitan.
Miller.
Mining Journal.
Moniteur des Arts.
Musical Standard.
Musical World.
Nature.
Photographic News.
Produce Markets' Review.
Queen.
School Board Chronicle.
Schoolmaster.
Scientific American.
Staffordshire Sentinel.
Statist.

Temperance Record.
United States Patent Office, Official Gazette.
Warehousemen & Drapers' Trade Journal.

Fortnightly.

Art Interchange.
Brewers' Guardian.
British and Colonial Printer and Stationer.
Corps Gras Industriels.
Finance Chronicle and Insurance Circular.
Gaceta Industrial.
Ingénieur Conseil.
Jeweller and Metal Worker.
Monde de la Science et de l'Industrie.
Publishers' Circular.
Review of Gas and Water Engineering.

Monthly.

American Journal of Industry.
Analyst.
Annales du Génie Civil.
Antiquary.
Artist.
Bookseller.
British Trade Journal.
Building World.
Canadian Patent Office Record.
Caterer, Hotel Proprietor and Refreshment Contractor's Gazette.
Chemist and Druggist.
Chronique Industrielle.
Crónica de la Industria.
Decoration.
Educational Times.
Foreman Engineer and Draughtsman.
Gas Engineer.
Journal of Applied Science.
Journal of Education.
Journal Telegraphique.
Leather Trades' Circular.
Lumière Electrique.
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Manufacturers' Review and Industrial Record
Mineral Water Trades' Review.
Monatsschrift für den Orient.
Moniteur Scientifique.
Nautical Magazine.
Orchestra and the Choir.
Paper Makers' Circular.
Photographic Times and American Photographer.
Pottery Gazette.
Provisioner.
Revue des Industries.
Revue Industrielle.
Revue Maritime et Coloniale.
Saddlers, Harness-makers, and Carriage Builders' Gazette.
Sanitary Engineer.
Sanitary Record.
Stationer.
Sugar Cane.
Symons's Meteorological Magazine.
Telegraphic Journal and Electrical Review.
Textile Manufacturer.
Watchmaker, Jeweller, and Silversmith's Trade Journal.
Wine Trade Review.
Workmen's Hall Messenger.

Two-Monthly.

Coach Builders' Harness Makers', and Saddlers' Art Journal.

Quarterly.

Journal of Mental Science.
Paper and Printing Trades' Journal.

NEWSPAPERS.

City Press.
Nottinghamshire Guardian
Sheffield and Rotherham Independent.
Staffordshire Sentinel.

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